Valley Water

Clean Water • Healthy Environment • Flood Protection

DRAFT Countywide Water Reuse Master Plan

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Limitations:

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GLOSSARY

The following definitions are established for use within this Countywide Water Reuse Master Plan. While many terms listed here are industry standard[1], several are specific to Valley Water or this plan.

Foundational Terms

- **Potable Water** is drinking water that meets or exceeds state and federal drinking water standards.
- **Non-potable** is water not fit for human consumption.
- **Recycled Water,** or sometimes called "purple pipe" due the distinguishing color of infrastructure reserved for its conveyance and distribution, generally refers to treated domestic wastewater used more than once before passing back into the water cycle. While the terms water reuse and recycled water are used interchangeably in some settings, for the purpose of this Countywide Water Reuse Master Plan, the term recycled water indicates non-potable reuse.
- **Reuse, or Water Reuse,** applies to both non-potable reuse (recycled water) and potable reuse, further described below.

Water Reuse Types

- **Non-potable Reuse (NPR)** refers to recycled water that is not used for drinking, but is safe to use for irrigation, industrial uses, or other non-drinking water purposes.
  - **Enhanced NPR, or NPR+** is recycled water for non-potable reuse that has been blended with purified water to remove salts and other dissolved solids to enable broader application of recycled water for non-potable end uses and protect groundwater quality
- **Potable Reuse** refers to recycled water sufficiently purified through advanced treatment to meet or exceed federal and state drinking water standards and is safe for human consumption. Potable reuse takes one of two forms: indirect or direct potable reuse.
  - **Indirect Potable Reuse (IPR)** water is blended with supply in another environmental system, such as an above-ground reservoir or groundwater basin, that acts as a buffer for retaining and diluting the reuse supply before conventionally treating the blended supply. IPR can be accomplished through groundwater recharge or surface water augmentation.
    - **Groundwater Recharge (GWR)** is a process that occurs naturally as part of the water cycle and/or is enhanced by using constructed facilities to increase water supply in a groundwater aquifer (natural underground water storage) by spreading water across infiltration basins, or ponds or by pumping water directly into the subsurface through injection wells
    - **Surface Water Augmentation (SWA)** involves increasing water supply in a surface water reservoir by introducing purified water
  - **Direct Potable Reuse (DPR)** involves the treatment and distribution of purified water using engineering controls, without an environmental buffer. Water is distributed directly into a

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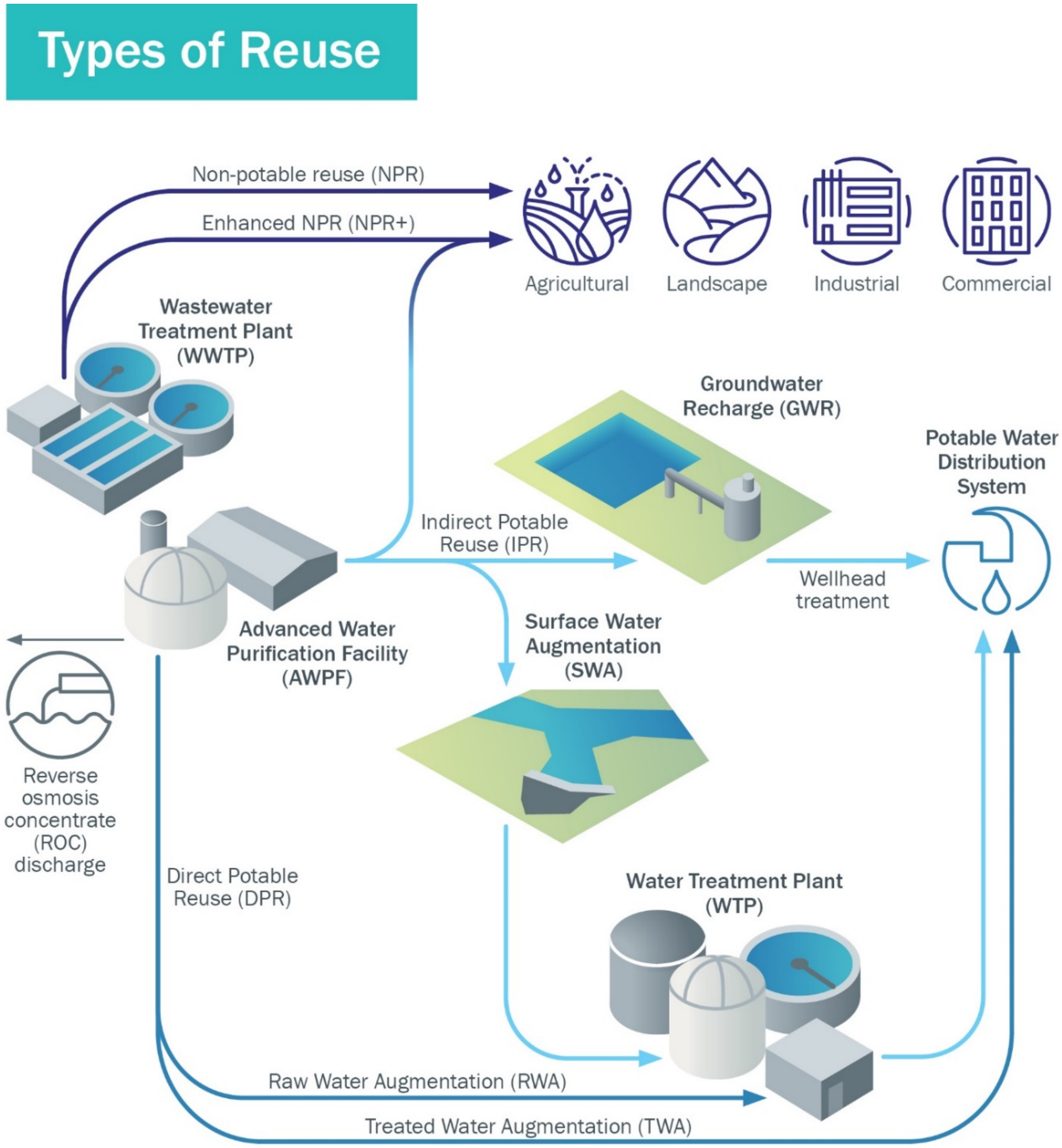
[1] Many definitions listed here are based on the Water Reuse Terminology summary (June 2016) posted on WateReuse Association's website and developed by WateReuse California, Association of California Water Agencies, and California Association of Sanitation Agencies. https://watereuse.org/educate/water-reuse-101/glossary/

potable water supply distribution system downstream of a water treatment plant or into the source water supply immediately upstream of the water treatment plant.

- **Raw Water Augmentation (RWA)** is the planned placement of recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant that provides water to a public water system.
- **Treated Water Augmentation (TWA)** is the planned placement of purified water directly into a finished (potable) water distribution system


Types of Reuse
Non-potable reuse (NPR)
Enhanced NPR (NPR+)
Agricultural
Landscape
Industrial
Commercial
Wastewater Treatment Plant (WWTP)
Groundwater Recharge (GWR)
Potable Water Distribution System
Indirect Potable Reuse (IPR)
Wellhead treatment
Advanced Water Purification Facility (AWPF)
Surface Water Augmentation (SWA)
Reverse osmosis concentrate (ROC) discharge
Direct Potable Reuse (DPR)
Water Treatment Plant (WTP)
Raw Water Augmentation (RWA)
Treated Water Augmentation (TWA)

Visual Glossary: Types of reuse explored for Valley Water's Countywide Water Reuse Master Plan

Water Uses and Delivery Methods

- **Augmentation** is the process of adding recycled or purified water into an existing raw water supply (such as a reservoir, lake, river, wetland, and/or groundwater basin).
- **Beneficial Reuse** is the use of recycled water for purposes that contribute to the water needs of the economy and/or environment of a community.
- **Delivery Points** are locations where treated water would be conveyed for reuse (NPR or PR).
- **Environmental Flow/Benefit** is water quantity, timing, and quality to sustain ecosystems/ habitats/natural systems
- **Irrigation** is the physical application of water to land to assist in the production of crops or landscape.
- **Retrofit** is the process of constructing and separating potable and recycled water pipelines that allows recycled water to be used for non-potable purposes. This also includes the process of preparing customer use sites for recycled water use.

Water Types and Quantity

- **Raw Water** is surface or groundwater that has not gone through an approved water treatment process.
- **Wastewater** is the used water of a community (domestic households and commercial businesses for washing food, dishes, clothes, and bodies and for toilet flushing) or industry that contains dissolved and suspended matter.
- **Sewershed** is a sewer collection system that flows to a single end point for treatment; akin to watersheds in the natural environment but focused on wastewater and built environment
- **Source Control** is careful management of harmful chemicals that may be introduced into the wastewater collection system
- **Reused Water** is water used more than once and has been treated to a level that allows for its reuse for a beneficial purpose.
- **Purified Water** is highly treated water of wastewater origin that has passed through proven multistage, multibarrier processes to produce water at the quality fit to supplement or provide supply for potable (drinking) water purposes, as verified through monitoring for its safety and as regulated by the State Water Resources Control Board Division of Drinking Water
- **Acre-feet per Year (AFY)** is a metric for the volume of water use and/or supply over one year; approximately a football field in area, filled to one foot in depth.
- **Efficiency** is a metric for AWPFs calculated as purified water produced divided by the facility's design capacity; efficiency reflects the AWPF's online factor (i.e., percent of time equipment is online vs. offline for regular maintenance) as well as source water availability
- **Million Gallons per Day (mgd)** is a measurement of flow that represents a volume of water supplied, treated, discharged, or conveyed over one day or a facility capacity (maximum physical limit). Used in context of average water/wastewater use over any timescale or peak flows over a shorter timescale
- **Utilization** is the average amount of purified water used for potable reuse divided by potable reuse capacity; utilization is dependent on delivery point conditions (e.g., groundwater storage capacity and water demand)
- **Yield** is the annual volume of water produced by a facility or natural system; generally lower than the maximum production (design) capacity due to source water availability, maintenance, and other factors that affect AWPF efficiency

Water Purification Treatment

- **Multi-barrier Processes** are purification processes that consist of several stages to confirm sufficient reduction and/or elimination of various substances that need to be controlled. As in all processes, monitoring is important to confirm the processes are working properly and efficiently. Membrane filtration, reverse osmosis, advanced oxidation, riverbank filtration, soil aquifer treatment, and constructed wetlands all may be parts of a multi-barrier purification process. Not all of these processes are needed in all situations.
- **Soil Aquifer Treatment** occurs when water, including recycled water, soaks into the ground and is passively purified by the physical, chemical, and biological processes that naturally occur in soil.
- **Ozonation** is the process of applying ozone (O_3), a strong oxidant, to disinfect water.
- **Granular Activated Carbon** is used to remove chemicals that are dissolved in water.
- **Advanced Oxidation** is one of the processes that can be used as a safety barrier in the water purification process. Hydrogen peroxide, ultraviolet (UV) light and other processes are used in combination to form a powerful oxidant that provides further disinfection of the water and breaks down chemicals.
- **Reverse Osmosis** is a method of removing dissolved salts and other constituents from water. Pressure is used to force the water through a semi-permeable membrane that transmits the water but stops most dissolved materials from passing through the membrane. This treatment method is commonly used in desalination, a process that takes salt out of seawater.

Wastewater Treatment Processes and Flow Streams

- **Influent** is the untreated water that flows into a wastewater treatment plant.
  - **Average Dry Weather Flow (ADWF)** is the average daily wastewater influent flow during the three lowest consecutive flow months of the year (e.g., June through August or July through September), typically presented in million gallons per day
- **Discharge** is the release of effluent, which meets regulatory standards, and designated by a regulatory permit to be safely discharged into the environment without causing harm.
- **Effluent** is the treated water discharged from a wastewater treatment plant
  - **Remaining Effluent** is the amount of secondary- or tertiary-treated wastewater available for potable reuse (or other uses such as discharge or blending) after NPR demands, losses, and environmental flows are met; for planning purposes, the Countywide Master Plan assumes all remaining effluent would be available for potable reuse
- **Primary Treatment** is a wastewater treatment process where solid matter is removed. The remaining liquid may be discharged or subjected to further treatment.
- **Secondary Treatment** is a wastewater treatment process where dissolved and suspended biological matter is removed to a non-potable level, so water may be disinfected and discharged into a receiving surface water or used for irrigation at controlled locations.
- **Tertiary Treatment** refers to treatment processes to remove nitrogen and phosphorus for uses such as irrigation, discharges into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers), or blending with other environmental systems such as a river or groundwater basin. Tertiary treatment can include biological and filtration processes.
- **Advanced Water Treatment or Advanced Water Purification** refers to processes that purify water for uses such as irrigation or for water blended with other environmental systems such as a river, reservoir, or groundwater basin prior to reuse. Advanced water treatment can also include

treatment processes to remove nitrogen and phosphorus in order to allow discharge into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs, etc.)

Planning Approaches

- **One Water Plan** is Valley Water's framework for incremental, intentional, and measurable improvement in water resources management and watershed conditions short term and over decades; within this vision, Valley Water will continue to operate under the current commitments, regulations, restrictions, and challenges that drive day-to-day operations
- **Portfolio** is a combination of individual project components; a project alternative
- **Programmatic Approach** is a strategic arrangement of individual, interlinked projects that collectively yield large-scale impacts, such as the Countywide approach to improving regional water supply reliability through considering a range of water reuse opportunities
- **Rubric** is a framework used for evaluating the potable reuse portfolios based on various regulatory criteria.

Regulations and Permits

- **Title 22 Standards** are the requirements established by the State Water Resources Control Board Division of Drinking Water (formerly the California Department of Public Health) for the production and use of recycled water. Title 22, Chapter 3, Article 3 of the California Code of Regulations, outlines the level of treatment required for allowable uses for recycled water. The most typical uses include irrigation, firefighting, residential landscape watering, industrial uses, food crop production, construction activities, commercial laundries, toilet flushing, road cleaning, recreational purposes, lakes, ponds and decorative fountains. Section 13550 of the California Water Code is a declaration by the State Legislature that the use of potable water is a waste if recycled water is available.
- **National Pollutant Discharge Elimination System (NPDES)** was instituted as part of the Clean Water Act, a permit program that controls water pollution by regulating point sources.

Master Plan Partnerships and Engagement

- **Partner Agencies** consist of staff from the City of Palo Alto, City of Mountain View, City of Sunnyvale, City of San José, City of Santa Clara, City of Morgan Hill, and City of Gilroy that represent the four recycled water producers in Santa Clara County, along with operators of recycled water systems. Valley Water must work closely with these partner agencies in order to secure source water for reuse and help the partner agencies meet their own reuse supply goals.
- **Project Partners** consist of the Partner Agencies and Valley Water. Collectively, they form the **Project Partner Group (PPG)** that has meets periodically to shape project alternatives / portfolios.
- **Executive Leadership Group (ELG)** refers to executive-level representatives (e.g. city manager or division manager) from the Partner Agencies who contribute to the Master Plan project direction.
- **Stakeholder Task Force** refers to representative interests/organizations related to business/ economy, chambers of commerce, planning, public policy, environmental advocacy, environmental justice, medical community, diversity, stormwater, groundwater, other water and recycled water suppliers/agencies that are invited to participate in Master Plan project meetings and share suggestions and concerns regarding project direction.
- **Independent Advisory Panel (IAP)** is a third-party body composed of leading potable reuse researchers and subject matter experts that is invited to review and provide feedback on proposed Master Plan project portfolios and options related to technical feasibility and regulatory compliance.

ABBREVIATIONS

AB	Assembly Bill
ADWF	average dry weather flow
AFY	acre-feet per year
AWPF	advanced water purification facility
BARR	Bay Area Regional Reliability
Cal Water	California Water Service Company
CC	Central Coast
CCR	California Code of Regulations
CDPH	California Department of Public Health
CEC	contaminant of emerging concern
CIWQS	California Integrated Water Quality System
CWC	California Water Code
DDW	State Water Resources Control Board’s Division of Drinking Water
DPR	direct potable reuse
FAT	full advanced treatment
GM	General Manager
GWR	groundwater recharge
IAP	Independent Advisory Panel
IPR	Indirect potable reuse
JPA	Joint Powers Agreement
LAFCO	Local Agency Formation Commission
LGRP	Los Gatos Recharge Ponds
mg/L	milligrams per liter
mgd	million gallons per day
NPDES	National Pollutant Discharge Elimination System
North County	northern portion of Santa Clara County
NPR	non-potable reuse
NPR+	Enhanced NPR, a blend of NPR with water from AWPF
PR	potable reuse
Regional Board	Regional Water Quality Control Board
RO	reverse osmosis
ROC	RO concentrate

ROCM	ROC Management
RWA	raw water augmentation
RWC	Recycled Water Committee
RWMP	Recycled Water Master Plan
RWQCP	Palo Alto Regional Water Quality Control Plant
RWS	recycled water system
SBWR	South Bay Water Recycling
SCRWA	South County Regional Wastewater Authority
SF Bay	San Francisco Bay
SJ/SC RWF	San José-Santa Clara Regional Wastewater Facility
SNMP	Salt and Nutrient Management Plan
South County	southern portion of Santa Clara County
State Board	State Water Resources Control Board
SVAWPC	Silicon Valley Advanced Water Purification Center
SWA	surface water augmentation
TDS	total dissolved solids
TM	technical memorandum
TMF	technical, managerial, and financial
TWA	treated water augmentation
UV	ultraviolet
UWMP	Urban Water Management Plan
Valley Water	Santa Clara Valley Water District
WPCP	Sunnyvale Water Pollution Control Plant
WQOs	water quality objectives
WRR	water reclamation requirements
WSMP 2040	Valley Water’s Water Supply Master Plan 2040
WTP	water treatment plant
WWTP	wastewater treatment plant

Section 1:

Introduction

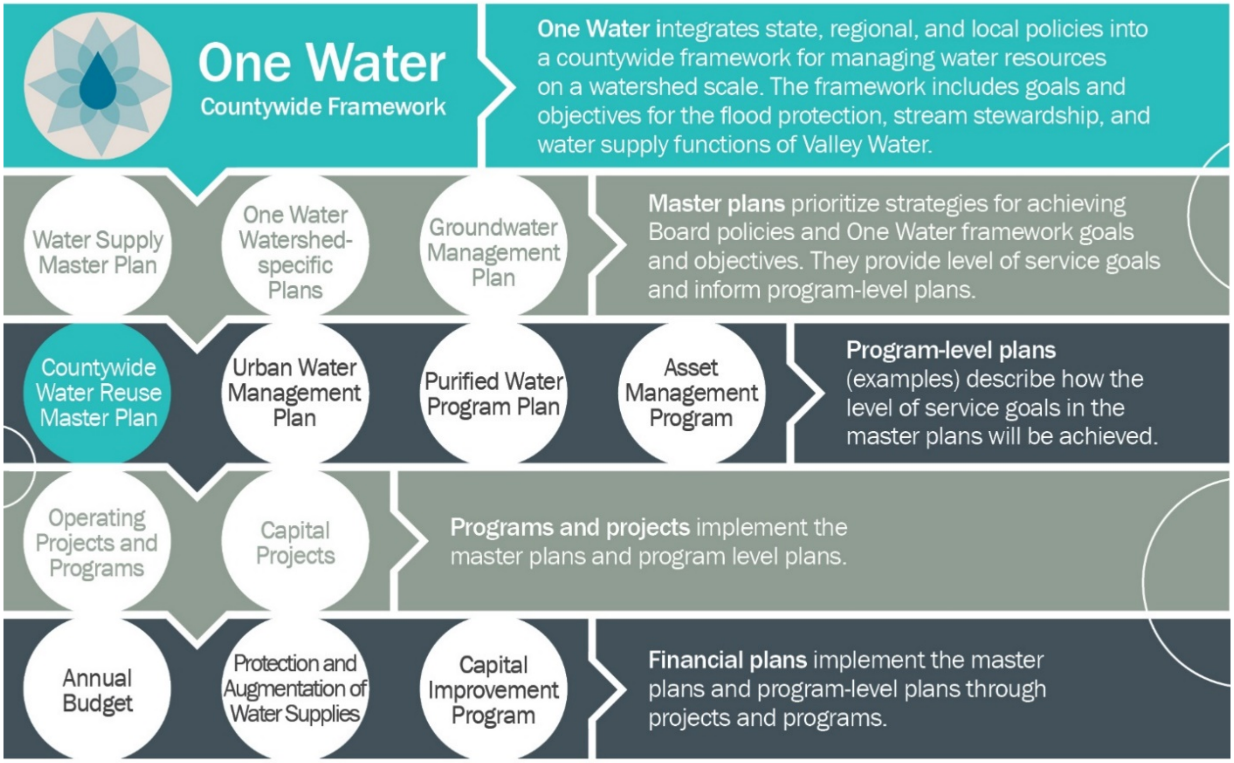
The mission of Santa Clara Valley Water District (Valley Water) is to provide Silicon Valley safe, clean water for a healthy life, environment, and economy. Achieving this mission requires a holistic, One Water approach supporting individual elements.

1.1 One Water Approach

In support of its mission, Valley Water developed the One Water Plan as a 50-year roadmap for integrated water resource planning on a watershed scale. The Plan brings together state, regional, and local policies into a Santa Clara Countywide framework with goals and objectives for Valley Water's three mission components of flood protection, stream stewardship, and water supply. One Water seeks to provide guidance from an overarching perspective and look for opportunities to further protect and enhance water resources.

Valley Water's holistic, forward-looking approach to water resource management and stewardship includes the One Water approach. This approach leverages partnerships to diversify local water resources, integrate systems to maximize water quantity and quality, and deliver projects that provide multiple benefits. Key objectives include:

- Reliable water supply
- Sustainable groundwater
- High-quality water
- Flood risk reduction
- Expanded floodplains
- Supportive stream flows
- Resilient habitats
- Climate change adaptation
- Emergency preparedness
- Community engagement


One Water
Countywide Framework
Water Supply Master Plan
One Water Watershed-specific Plans
Groundwater Management Plan
Countywide Water Reuse Master Plan
Urban Water Management Plan
Purified Water Program Plan
Asset Management Program
Operating Projects and Programs
Capital Projects
Annual Budget
Protection and Augmentation of Water Supplies
Capital Improvement Program

One Water integrates state, regional, and local policies into a countywide framework for managing water resources on a watershed scale. The framework includes goals and objectives for the flood protection, stream stewardship, and water supply functions of Valley Water.

Master plans prioritize strategies for achieving Board policies and One Water framework goals and objectives. They provide level of service goals and inform program-level plans.

Program-level plans (examples) describe how the level of service goals in the master plans will be achieved.

Programs and projects implement the master plans and program level plans.

Financial plans implement the master plans and program-level plans through projects and programs.

Figure 1-1. Valley Water's One Water Plan as a Countywide framework

1.2 Water Supply Planning

In support of its mission, Valley Water has invested in programs and projects over many decades to manage water demands, protect and develop water supplies, maintain existing infrastructure, and construct new facilities. As described in Valley Water's Water Supply Master Plan 2040 (WSMP 2040), these past and ongoing investments enable Valley Water to manage natural variability in demands and supplies to meet Santa Clara County's current water needs in all but critical drought years—and yet, the county's need for water, particularly reliable dry-year supplies, will continue to grow.

Valley Water's Board of Directors established a goal to increase recycled water use, such that reuse supplies meet 10 percent of total Countywide demands by 2025 and a Drought Response Target of 24,000 acre-feet per year (AFY) by 2040. There are many drivers for diversifying and expanding the county's water supply portfolio—including population/ economic growth, increasing climate uncertainty, and other challenges to supply resilience. Recent technological advancements and regulatory developments have made it possible for Valley Water to pursue water reuse as a viable local, drought-resistant potable (drinking water) supply.

The WSMP 2040 evaluates Valley Water's ability to meet Santa Clara County's projected water demands through year 2040 under various conditions and scenarios. Hydrologic conditions considered range from normal water years to 6 sequential drought years, and scenarios begin with a baseline water supply system and build by layering various potential supply projects to address anticipated shortfalls based on comparing projected future demands and supplies. The baseline water supply system reflects an increase in water retailers' non-potable reuse (NPR) from 18,000 AFY in 2018—an estimated 6 percent of Countywide demands that year—to about 28,000 AFY in 2025 and 33,000 AFY in 2040.

Based on the WSMP 2040 water demand forecasts, meeting the Board's goal will require designing and constructing new facilities to begin producing at least 9,000 AFY of potable reuse (PR) supply by 2025.

Further, the WSMP 2040's strategy identifies key goals for 2040 supplies needed to ensure sustainability and resilience to a 6-year design drought, including a contribution of 57,000 AFY of reuse to diversify and strengthen Valley Water's supply portfolio (14 percent of projected Countywide demands in 2040)—composed of 33,000 AFY for NPR and 24,000 AFY for PR.

For the purpose of estimating costs and schedule, the WSMP 2040 assumes the reuse target will be achieved by implementing a specific project—the Los Gatos Recharge Ponds (LGRP) PR project. This project involves sending purified water from San José to existing ponds along Los Gatos Creek in Campbell for groundwater recharge (GWR)—while the WSMP 2040 acknowledges that Valley Water's Countywide Water Reuse Master Plan will identify and evaluate other options for achieving the 2040 reuse target.

Achieving Valley Water's goal of meeting at least 10 percent of the County's 2025 water demands using recycled water will require developing potable reuse and increasing non-potable reuse consistent with Partner Agencies' recycled water system expansion plans.

> **"We are the primary water resources agency for all of Silicon Valley, so it's our job to manage and plan for current and future water needs to ensure our region's sustainability," Valley Water Board member Barbara Keegan said. "This includes not just managing the day-to-day water needs for Silicon Valley's residents, businesses, and environment, but also investing in innovative technologies and long-range planning for the region's water needs. By taking a comprehensive, integrated approach to this vital resource, we can protect and preserve it for the benefit of both current and future generations, as well as our valley's environment."**
>
> — U.S. Water Alliance One Water Spotlight, March 2016

1.3 Countywide Master Plan Goals and Objectives

Valley Water initiated the Countywide Master Plan effort to identify feasible opportunities to expand water reuse as part of the strategy to improve water supply reliability and increase regional self-reliance for the Santa Clara County's nearly 2 million residents and growing economy.

Over decades, Valley Water methodically advanced water reuse in the county by leading planning efforts, developing wholesale recycled water programs, and constructing new infrastructure. Critical to a successful outcome, development of the Countywide Master Plan must align with Valley Water's One Water Plan and WSMP 2040 and engage project partners to collaboratively identify and evaluate opportunities for expanding reuse.

This vision evolved over recent years and expanded into a programmatic approach and collaborative effort to develop a Countywide reuse strategy that aims to:

1 Integrate existing recycled water systems and expand NPR

2 Develop purified water systems in partnership with recycled water producers/suppliers and other interested parties to enable potable reuse.

The Countywide Master Plan provides a framework to make collaborative decisions and implement integrated actions to increase water supply reliability throughout the region.

Other Countywide Master Plan objectives are to:

Determine source water availability and reuse benefits. Includes identifying sources and reliable amounts of water available for reuse, the appropriate split between NPR and PR, and regional (Countywide) and local-level (individual project partner) benefits from NPR and PR.

Evaluate potential regional integration. Optimizes use of supply and infrastructure, builds on existing planning studies, and improves system reliability and flexibility. Considers innovative approaches and provides a basis for collaboration, interagency agreements, and governance related to residuals management, permitting, and land use decisions.

Support regional collaboration and establish a foundation for continued outreach. Develops and evaluates reuse opportunities—individual projects and collective portfolios that combine projects—and considers implementation pathways. Increases public support of water reuse through outreach.

To achieve these objectives, Valley Water is collaborating with Partner Agencies (introduced below) that own and operate four separate wastewater treatment plants (WWTP) and recycled water distribution systems in the County. Figure 1-2 identifies the sewersheds contributing flow to each of the four WWTPs: Palo Alto Regional Water Quality Control Plant (RWQCP), Sunnyvale Water Pollution Control Plant (WPCP), San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF), and South County Regional Wastewater Authority (SCRWA).

The four WWTPs produce source water for reuse, and recycled water distribution systems deliver the supply to end users. In some circumstances, a water supplier purchases recycled water from a producer (i.e., from a WWTP) on a wholesale basis, and the wholesaler provides the recycled water supply to a retailer that delivers water directly to end users.

The collaboration between Valley Water and the Partner Agencies helps build on existing partnerships, plans, and infrastructure; explore a wide range of reuse opportunities that support Valley Water’s goals; and yield multiple benefits for the collective region.

Partner Agencies include:

Recycled Water Producers (WWTPs)

Palo Alto Regional RWQCP

The Palo Alto RWQCP treats wastewater flows from the cities of Palo Alto, Los Altos, Los Altos Hills, and Mountain View; East Palo Alto Sanitary District; and Stanford University. The RWQCP produces and distributes tertiary treated recycled water through the Palo Alto/Mountain View Recycled Water System (RWS).

Sunnyvale WPCP

The Sunnyvale WPCP treats wastewater flows from the City of Sunnyvale. A portion of flow at the WPCP receives tertiary treatment that is then distributed as recycled water to retail customers through the Sunnyvale RWS.

SJ/SC RWF

As the largest WWTP in the county, the SJ/SC RWF treats wastewater flows from the cities of San José and Santa Clara (co-owners of the RWF); the cities of Milpitas, Cupertino, Los Gatos, Saratoga, and Monte Sereno; and County Sanitation District No. 2-3 (collectively known as Tributary Agencies). In the 1990s, projected population growth and the RWF's effluent discharge limitations set by the National Pollutant Discharge Elimination System (NPDES) permit inspired San José and Valley Water to collaborate in planning development of the South Bay Water Recycling (SBWR) system, a resource recovery system that reuses treated effluent from the RWF for non-potable purposes. Originally, SBWR was constructed to comply with regulations protecting salt marsh habitat by reducing SJ/SC RWF effluent discharges to the San Francisco Bay (SF Bay). In short order, SBWR's water supply benefits became evident.

SCRWA

The cities of Gilroy and Morgan Hill are members of this joint powers authority (JPA) formed to manage treatment of wastewater flows from these two municipalities in the southern portion of Santa Clara County (South County) at the SCRWA WWTP in Gilroy. The South County RWS distributes tertiary-treated recycled water from the WWTP to NPR end users in Gilroy.

Recycled Water Systems

Palo Alto/Mountain View RWS

Palo Alto distributes recycled water from the RWQCP to end users (retail sales) within its service area and provides Mountain View up to 3 million gallons per day (mgd), measured as an instantaneous flow, on a wholesale basis. In 2019, Valley Water, Palo Alto, and Mountain View executed a long-term, 75-year agreement establishing terms for Valley Water to receive 9 mgd of RWQCP effluent for future potable reuse and for subsidized funding of a new 1.25- to 2.5-mgd local advanced water purification facility (AWPF) in Palo Alto. Purified water from the AWPF will blend with tertiary-treated effluent from the RWQCP to reduce total dissolved solids (TDS)—i.e., remove salts—resulting in improved recycled water quality. This blend is referred to as enhanced NPR, or NPR+, and enables broader application of recycled water for non-potable end uses.

Sunnyvale RWS

The Sunnyvale RWS recently expanded with construction of the 2.5-mile Wolfe Road Pipeline—the outcome of a partnership between Valley Water and Sunnyvale that began in 2013 with designing the pipeline to serve customers south of the San Lucar Pump Station and within Cupertino. As part of this institutional arrangement, Valley Water acts as a recycled water wholesaler and provides recycled water to the California Water Service Company (Cal Water), a retailer serving customers on the Wolfe Road Pipeline. The pipeline was designed to allow Cal Water to deliver recycled water from Sunnyvale's RWS to Apple's campus in Cupertino. Valley Water and Sunnyvale are jointly evaluating additional water reuse alternatives, including an AWPF near the Sunnyvale WPCP.

South Bay Water Recycling

SBWR is a recycled water wholesaler and regional permit holder overseeing regulatory compliance for the quality of recycled water produced at the SJ/SC RWF and its use in the cities of San José, Santa Clara, and Milpitas. Operated by the City of San José, SBWR is funded by the SJ/SC RWF capital and operation budget and wholesale recycled water sales to four local water retailers: the cities of San José (via San José Municipal Water), Santa Clara, and Milpitas; and San Jose Water (an investor-owned utility). Over decades, Valley Water and San José have executed a variety of agreements pertaining to reuse. An agreement established in 2010 set terms for constructing the Silicon Valley Advanced Water Purification Center (SVAWPC), which began operations in 2014. Currently, purified water from the SVAWPC is blended into the SBWR system to improve recycled water quality and reduce TDS. Separately, Valley Water and San José established the Silver Creek Pipeline Agreement that allows Valley Water to wholesale for 5 mgd of SBWR recycled water within a dedicated service area.

South County RWS

SCRWA's recycled water system began operating in 1977 during a historic drought. Operations became intermittent due to a lack of consistent demand for NPR and variabilities in recycled water quality until the 1990s.In 1999, Valley Water and SCRWA executed agreements that established cost-sharing terms and partnering to develop a reuse master plan and capital improvement program, and to define their respective roles pertaining to South County reuse—namely SCRWA as the NPR producer, Valley Water as the wholesaler, and the two municipalities as retailers (though Morgan Hill does not currently have a recycled water distribution system). Terms of one executed agreement establish that SCRWA may sell flows of recycled water that exceed the annual delivery quantity (a mutually agreed-upon flow established each year) to other wholesalers/end users, and Valley Water may sell recycled water to be used by end users outside of the South County RWS service area (with SCRWA's approval).

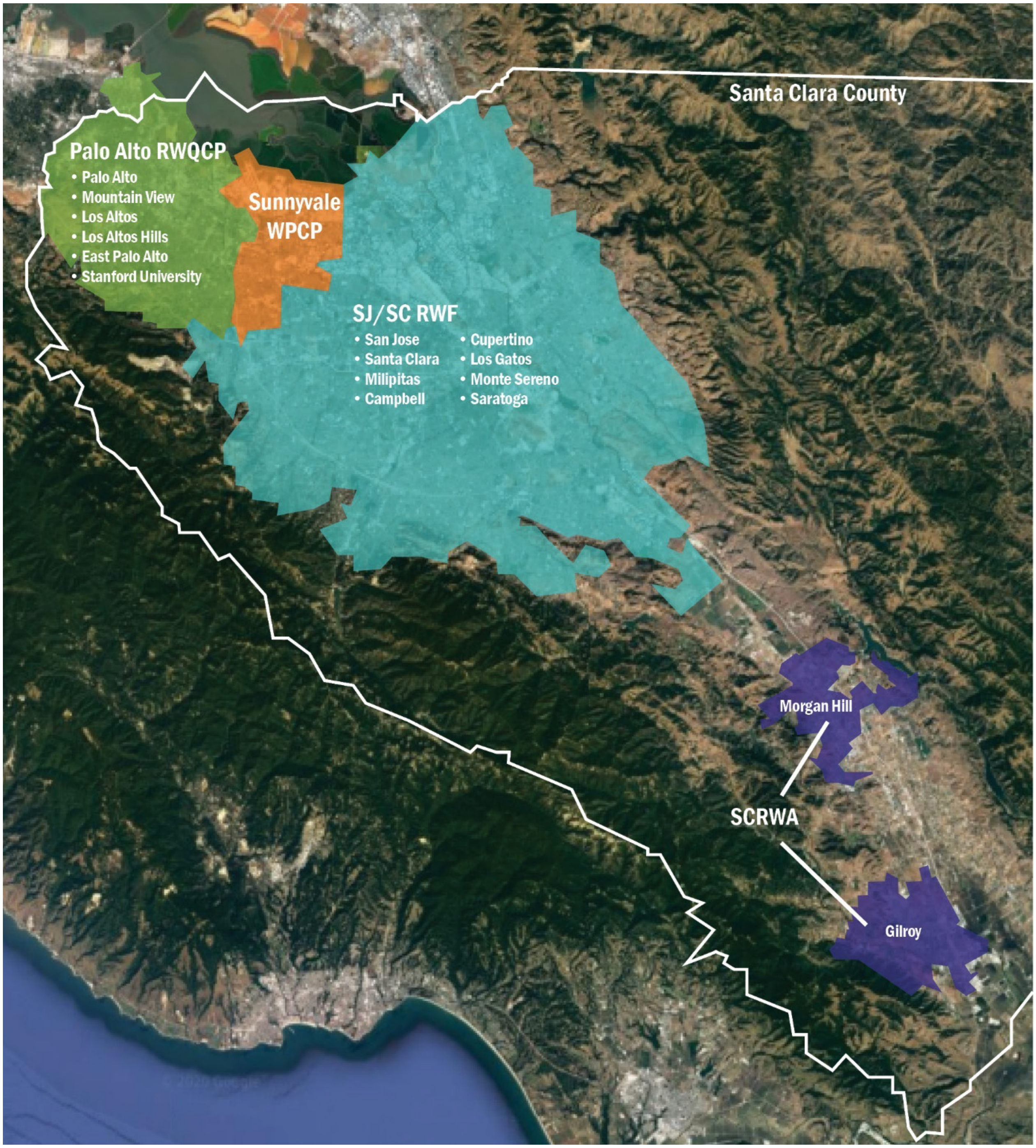


Figure 1-2. Partner Agencies' sewersheds contributing flow to each of the four WWTPs

Section 2:

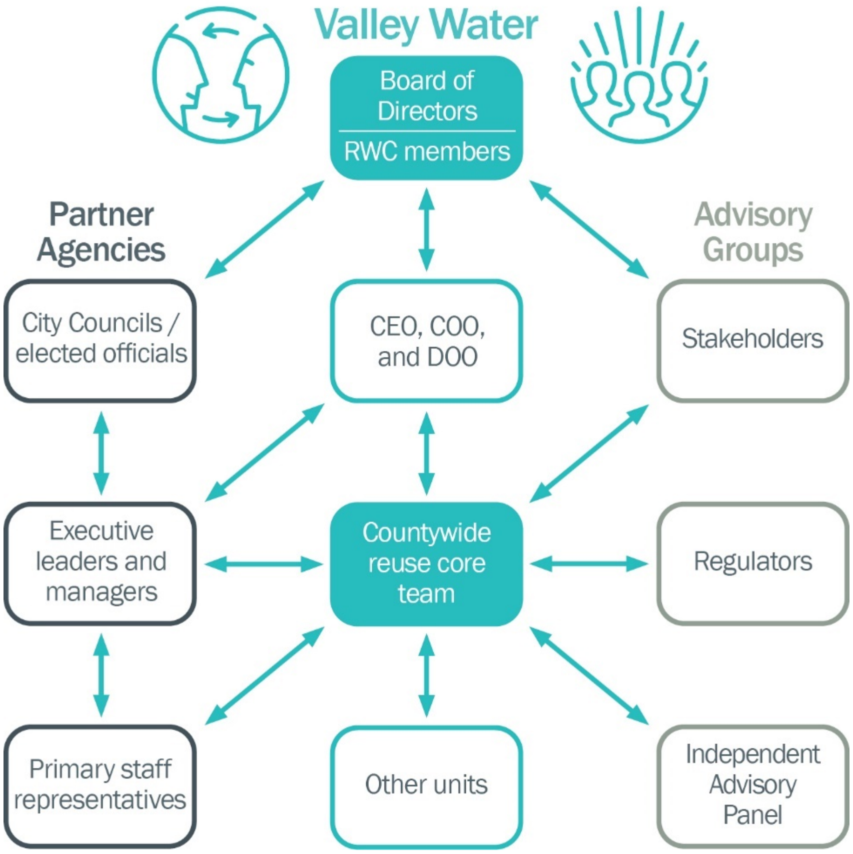
Partnerships and Engagement

Creating a blueprint for a new regional reuse program requires early, frequent, and meaningful collaboration among Valley Water, Partner Agencies, and stakeholders.

To develop and sustain a common vision for the region, robust engagement across various interest groups and levels is imperative. A Countywide approach can benefit the collective region by enhancing water supply reliability, increasing use of existing infrastructure investments, facilitating water transfers during critical shortages, and improving resilience to droughts and climate change.

The engagement approach established for developing the Countywide Master Plan enabled opportunities for a myriad of agencies and subject matter experts (as shown on Figure 2-1) to offer input to the plan's development, to garner good will, and to generate support.

Staff from Valley Water's Recycled and Purified Water Unit led development of this plan as a Countywide Reuse Core Team, in coordination with:



Valley Water
Board of Directors
RWC members
Partner Agencies
Advisory Groups
City Councils / elected officials
CEO, COO, and DOO
Stakeholders
Executive leaders and managers
Countywide reuse core team
Regulators
Primary staff representatives
Other units
Independent Advisory Panel

Figure 2-1. Blueprint for robust engagement and collaboration at multiple levels across various groups to inform the Countywide Master Plan development

VALLEY WATER'S POLICYMAKERS
Valley Water's Board of Directors, composed of seven elected representatives responsible for adopting policies to govern processes and the Board's Recycled Water Committee (RWC)

PARTNER AGENCIES
Partners' staff representing various levels of authority and roles, complementary to those of Valley Water, such as: policymakers (joint committees composed of elected officials and policymakers from Valley Water's RWC and Partner Agencies' city councils or policy advisory committees), executive managers, and staff representatives

ADVISORY GROUPS
Three distinct groups, defined as follows:

- **stakeholders** invited to participate as task force members, including representative interests/organizations related to business/ economy, chambers of commerce, planning, public policy, environmental advocacy, environmental justice, medical community, diversity, stormwater, groundwater, other water and recycled water suppliers/agencies
- **regulators** including the State Water Resources Control Board's Division of Drinking Water (DDW) and Regional Water Quality Control Boards, Region 2 (San Francisco Bay) and Region 3 (Central Coast)
- **Independent Advisory Panel (IAP)**, a third-party body composed of leading potable reuse researchers and subject matter experts

Note: CEO = Chief Executive Officer;
COO = Chief Operating Officer;
DOO = Deputy Operating Officer

While each aspect of the engagement strategy is important, collaboration with Partner Agencies is uniquely and critically important.

Partnerships between Valley Water and recycled water producers are key to unlocking a path forward for regional reuse. Long-term agreements between project partners are a critical premise for securing reliably available source water for reuse; the absence of which would call into question the realistic feasibility of implementing a Countywide program. Valley Water and Partner Agencies have invested substantial time and effort in collaborating to develop the Countywide Master Plan, and each Partner Agency provided valuable contributions and unique insight and perspective through group forums, one-on-one meetings, and written feedback that have been considered and, to the extent possible and practicable, addressed in the plan.

Engaging partners early in the process as key decisions are made paves the way for a feasible path forward.

This engagement approach sets the tone for continued collaboration as implementation of regional reuse strategies continues. Moving forward, Valley Water's collaboration strategy will continue to emphasize meaningful engagement across various groups and decision-making levels, including the public.

Valley Water will continue to be involved with establishing partnerships and creating new institutional structures to support a common vision for the region. Throughout this master planning process and in the future, Valley Water is committed to proactively addressing governance issues to help forge consensus among diverse stakeholders, memorialize commitments, and articulate the vision in actionable planning documents, such as this one.

The mechanism for input varies depending on influencing factors—such as group composition, project milestones/status, schedule sequencing/interdependencies—and take the form of group meetings, strategic workshops, one-on-one meetings, and written comments. Facilitated meetings and workshops start with empowering stakeholders with critical information to establish a clear, level baseline of working knowledge and support productive group dialogue and decision-making.

2.1 Reuse Roles and Responsibilities within Santa Clara County

Valley Water is governed by a seven-member Board of Directors who are elected to represent geographical districts in the County and serve overlapping four-year terms. At the Board's direction, Valley Water's CEO/General Manager (GM) and other executive managers oversee operations and performance of staff.

Valley Water's roles and responsibilities are shaped primarily by California state law (i.e., the District Act) along with various Board-established policies and institutional agreements with other parties. Additionally, Valley Water is considered an independent "special district", informally defined as a separate local government that delivers public services to a particular area.[2] Table 2-1 shows Valley Water's roles and responsibilities related to water reuse.

Table 2-1. Valley Water's Responsibilities as a Leader and Partner Advancing Countywide Reuse

Role	Valley Water's Responsibility
Countywide and regional planning for sustainable, resilient water supplies	Develop strategies to secure and optimize the use of existing water supplies and infrastructure and to expand water reuse and long-term water conservation savings. Lead Countywide water supply planning and coordinates with water retailers, reuse project partners, and external interest groups. Participate in a partnership—Bay Area Regional Reliability (BARR)—with seven other water suppliers throughout the region to improve integrated regional water management, drought mitigation, and supply resilience, and to optimize the regional sharing of water resources.
Water retailer assistance	Coordinate and collaborate regularly with the 13 local water retailers in the County to share information, offer technical support, and help develop regional alliances.
Reuse planning, funding, and facilities	Lead collaborative efforts and partnerships to plan reuse projects; cost-share to fund reuse projects; and construct, operate, and maintain reuse facilities.
Reverse osmosis concentrate management	Facilitate collaborative workshops with stakeholders to develop solutions for managing reverse osmosis concentrate (ROC)—a concentrated stream resulting from filtration using reverse osmosis—in addition to conducting pilot-scale testing of treatment alternatives.
Water conservation	Lead Countywide water conservation efforts with innovative, comprehensive programs.
Local surface water management	Operate and maintain 20 appropriative water rights[3] licenses and one filed water right permit with the State Water Resources Control Board totaling more than 227,300 AFY.
Groundwater management	Lead groundwater management efforts for Santa Clara County through comprehensive programs and investments, including storage of surface water in groundwater basins and in-lieu recharge to help balance pumping and provide reserves for use as water supply during dry years.

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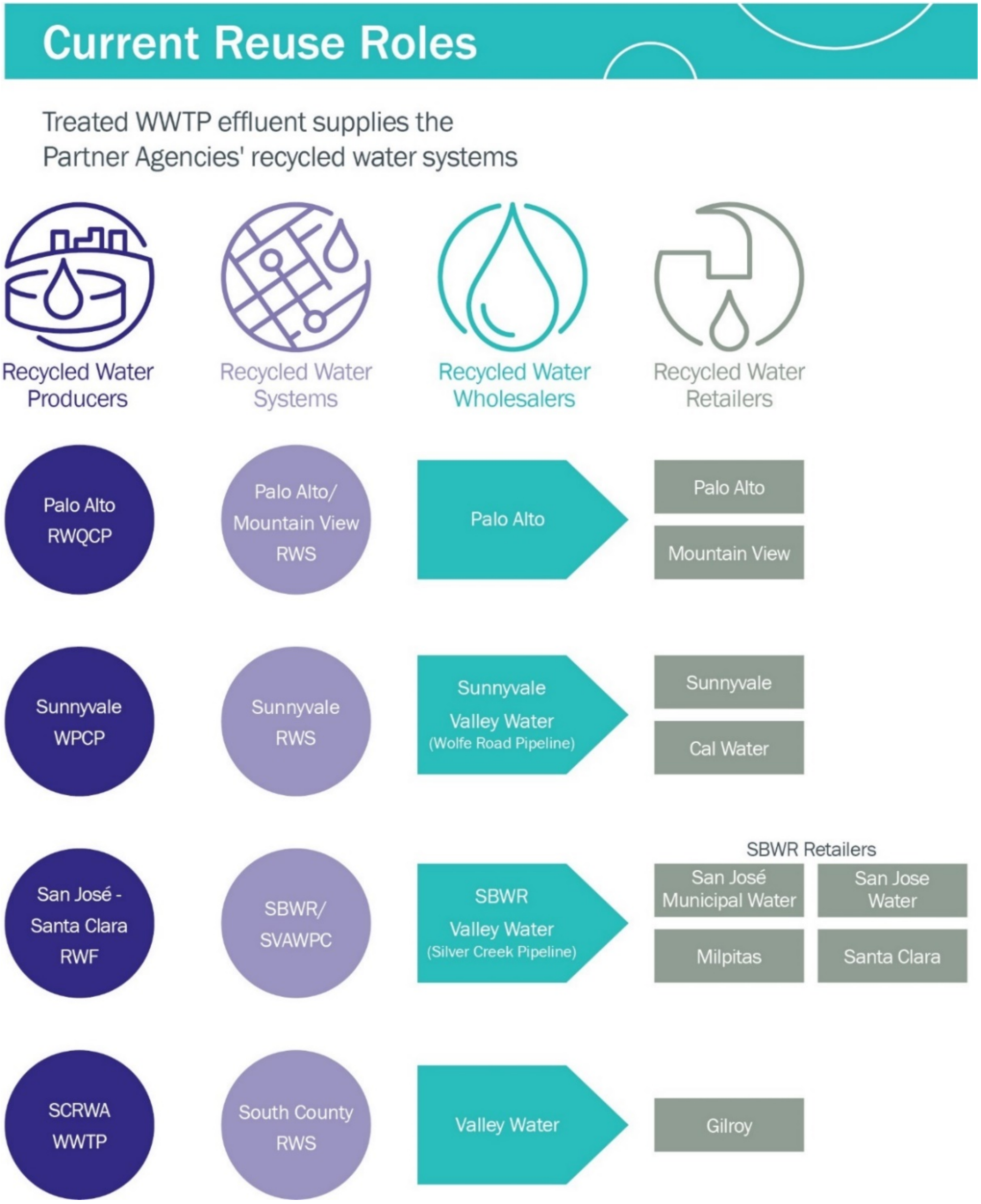
[2] Per Government Code §16271 [d], a special district is an agency of the state for the local performance of governmental or proprietary functions within a limited boundary. Separate generic statutes apply to special districts that are municipal water suppliers. While the respective Local Agency Formation Commission (LAFCO) administers the formation process, establishing a special district requires voter approval by individuals residing within the geographic area who would be influenced by its proposed fees/services. Special district formation typically requires a majority vote, though two-thirds voter-approval is needed if a proposal involves new special taxes. Special districts are governed by elected boards and may only provide public services allowed by state law.

[3] Under California law, appropriative water rights allow surface water to be diverted at one point and used (appropriated) beneficially at a separate point, in contrast to riparian rights based on ownership of property adjacent to a waterbody.

As described in Section 1, project partners for Countywide Water Reuse include Valley Water and the four Partner Agencies that operate the four WWTPs in the County and currently fulfill roles related to the treatment and delivery of recycled water through existing distribution systems. Figure 2-2 depicts project partners' roles in the treatment, delivery, and sale of recycled water to customers. Wholesalers buy water and sell it to retailers; retailers sell water directly to customers and provide customer service. A single entity may serve all roles as a recycled water producer, owner/operator of a recycled water system, wholesaler, and retailer—such as Palo Alto and Sunnyvale.



Current Reuse Roles

Treated WWTP effluent supplies the Partner Agencies' recycled water systems

Recycled Water Producers	Recycled Water Systems	Recycled Water Wholesalers	Recycled Water Retailers
Palo Alto RWQCP	Palo Alto/ Mountain View RWS	Palo Alto	Palo Alto Mountain View
Sunnyvale WPCP	Sunnyvale RWS	Sunnyvale Valley Water (Wolfe Road Pipeline)	Sunnyvale Cal Water
San José - Santa Clara RWF	SBWR/ SVAWPC	SBWR Valley Water (Silver Creek Pipeline)	SBWR Retailers San José Municipal Water San Jose Water Milpitas Santa Clara
SCRWA WWTP	South County RWS	Valley Water	Gilroy

Figure 2-2. Current roles and interagency relationships supporting reuse throughout the County

2.2 Relevant Institutional Arrangements

Current agreements between Valley Water and the Partner Agencies relevant to the Countywide Master Plan are summarized below. A comprehensive list of past and current agreements is included in Attachment B of ***Appendix D*** (Project Definition, Roles, and Responsibilities). Additional arrangements will be necessary to implement various project elements, as discussed in Section 8.3.1.

Palo Alto / Mountain View – 2019 Cost Sharing and Supply Agreement

[Expires December 10, 2095]

In December 2019, Valley Water executed an agreement with the cities of Palo Alto and Mountain View that defined cost sharing and supply commitments related to reuse. The agreement extends until December 10, 2095. Key provisions include:

- Cost-sharing for constructing a $20 million local AWPF in Palo Alto for enhanced NPR (NPR+) or other alternatives that benefit RWQCP partners.
- Commitment of 9 mgd of effluent (minimum annual average flow) from Palo Alto to Valley Water at a cost of ~$100/AF for treatment at a regional AWPF.

Sunnyvale – Wolfe Road Pipeline

[Expires 2025; renews every 5 years]

In 2015, Valley Water, Sunnyvale, Apple, and Cal Water agreed to cost-share construction of the Wolfe Road Pipeline. Key provisions of the Recycled Water Supply and Distribution Agreement between Sunnyvale (producer) and Valley Water (wholesaler) include:

- Valley Water owns, but Sunnyvale operates and maintains, the pipeline. Recycled water conveyed through the Wolfe Road Pipeline is owned by Valley Water and may be resold to Valley Water's other customers, regardless of whether they are located in Sunnyvale.
- For recycled water from Sunnyvale flowing through Wolfe Road Pipeline, a commitment of at least 500 AFY for Valley Water's distribution to users outside the city and an entitlement of up to 595 AFY (and option to purchase more, subject to Valley Water's approval) for Sunnyvale's end users within the city.

City of San José – SBWR Expansion and Silver Creek Pipeline

[Expires January 22, 2027]

In 2002, Valley Water and San José entered into a 25-year agreement to develop a framework for long-term ownership, operation, maintenance, and future expansion of SBWR, and to share costs to the Silver Creek Pipeline. Per the agreement, the City owns the pipeline and acts as wholesaler for recycled water to be delivered to the Metcalf Energy Center and other end users within San José Municipal Water's service area. Valley Water has rights to 5 mgd of recycled water from the Silver Creek Pipeline with the potential for more depending on availability.

City of San José – SVAWPC Agreements [Expire June 30, 2050]	Under the Ground Lease and Property Use Agreement, Valley Water must operate and maintain the SVAWPC, accepting up to 12 mgd of secondary effluent from the SJ/SC RWF to provide up to 8 mgd of purified water for NPR+ (targeting TDS levels of about 500 mg/L, which corresponds with the TDS limit for potable water and supports protection of groundwater quality). The Operations and Maintenance Agreement for SVAWPC requires the SJ/SC RWF to accept 1.5 mgd of waste stream discharge and 2 mgd of ROC.
SCRWA – Producer-Wholesaler Agreement [Expires December 31, 2026]	In October 1999, Valley Water entered into a series of three 20-year Producer-Wholesaler agreements (updated in 2006) that established SCRWA as the producer, Valley Water as wholesaler, and the City of Gilroy as retailer of recycled water. As part of the agreements, SCRWA may sell recycled water that exceeds the annual delivery quantity (a mutually agreed-upon flow established each year) to other wholesalers or end users, and Valley Water may sell recycled water to end users outside of the Producer's service area (with approval by SCRWA).

Note on Key Terminology:

mgd = million gallons per day: Used in context of treatment facility capacity, mgd is useful for presenting average water/wastewater use over any timescale or peak flows over a shorter timescale.

AFY = acre-feet per year: Used when discussing annual supply or demand over a longer timescale (one or more years). Overall project yield uses AFY.

Appendix A-2 (Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield) provides additional details.

In addition to Valley Water agreements, Partner Agencies have other contractual arrangements that establish financial/supply obligations and other requirements. In some cases, these obligations restrict flow for certain uses, and new or amended agreements may be required to make flow available for Countywide use. For example, under a current agreement that expires in 2060, Palo Alto is required to make recycled water available to Mountain View on a demand basis with a peak flow rate of up to 3 mgd. Both Palo Alto and Mountain View have the right to approve or reject proposals to extend their respective distribution systems and transfer recycled water through their own infrastructure and out of their service areas, provided they do not exceed their recycled water allocations.

Section 3:

Regulatory Framework

The Countywide Master Plan considers a wide range of reuse scenarios, giving way to a spectrum of applicable regulatory and permitting requirements. In general, regulations for water reuse fall into two categories: public health protection and environmental discharge protection.

Since the California Legislature began regulating water reuse in 1969, the state has enacted over 100 relevant statutes. Regulations and permit requirements are integral to shaping more detailed aspects of reuse projects. The intended use(s) of reuse supply and potential impacts to human health and the environment are at the core of these regulations and requirements, establishing clear, enforceable boundaries in the public interest. While end uses for reuse supply typically drive the selection of treatment processes, other factors must also be considered, such as programs requiring and overseeing source water quality control, monitoring, and response. In addition, careful consideration must be given regarding technical, managerial, and financial (TMF) capacities of the agencies responsible for treatment, conveyance, storage, and distribution of reuse supplies.

While this section merely introduces reuse regulations, ***Appendix B-2*** (Regulatory Framework Technical Memorandum [TM]) addresses the topic in substantially more detail.

3.1 Regulators and Respective Purviews

Upon adopting the Porter-Cologne Act in 1969, the California Legislature established a comprehensive program to protect water quality and beneficial uses of water, along with an agency with relevant statutory authority—the State Water Resources Control Board (State Board). The State Board is responsible for setting statewide water quality policy, establishing and enforcing water regulations, and overseeing water reclamation requirements (WRR).

The Act also established nine Regional Water Quality Control Boards (Regional Boards) that under the State Board's overall authority with roles defined by their respective individual geographic boundaries. Regional Boards hold the responsibility of administering permit systems to enforce compliance with water quality criteria for recycled water and discharge regulations.

Regional Board

Enforcement of Environmental Discharge Criteria:
Water quality requirements to protect surface water and groundwater quality for all designated beneficial uses

The State Board's Division of Drinking Water (DDW, formerly California Department of Public Health [CDPH]) has statutory authority over two aspects of water reuse: (1) regulation of public water systems in accordance with the California Safe Drinking Water Act (Health and Safety Code Section 116270 et seq.) and (2) development and adoption of water recycling criteria as required by Section 13521 of the California Water Code (CWC).

DDW

Enforcement of Public Health Protection Criteria:
Requirements for treatment, monitoring, and effluent water quality for the end use (e.g., landscape irrigation and GWR)

Primary responsibilities of the Regional Boards and DDW are further described as follows.

Regional Water Quality Control Boards

Regional Boards implement water quality planning and regulatory decisions for their specific regions, such as issuing waste discharge requirements (i.e., discharge permits), administering NPDES permits for receiving surface water bodies, and enforcing Salt and Nutrient Management Plan (SNMP) requirements for groundwater protection.

The SF Bay Regional Board (SF Bay; Region 2) regulates discharge facilities in the northern part of Santa Clara County (North County), while the Central Coast (CC) Regional Board (CC; Region 3) regulates SCRWA's discharges in the South County.

NPDES permits for discharges to surface waters contain specific requirements that limit the pollutants in discharge effluent.

Regional Boards are responsible for specific regulatory areas affecting water reuse:

- Approving pollutant source control programs for wastewater systems
- Issuing and enforcing water reclamation (reuse) requirements to producers and users
- Defining beneficial uses of surface water and groundwater bodies through water quality control plans
- Regulating treatment facility operators
- Determining water rights regarding reuse

In context of the Countywide Master Plan, three contemplated activities trigger the need to seek new or modified NPDES permits or WRRs[4] through Regional Boards, including discharging:

1. **Purified water to spreading basins for GWR**
2. **Purified water to Anderson Reservoir for surface water augmentation (SWA)**
3. **ROC discharge through surface water outfalls**

Most PR applications in California use full advanced treatment (FAT), which produce significant volumes of ROC that may contain concentrated levels of TDS, nutrients, metals, and toxicity. Depending on the circumstances, reuse projects that discharge ROC to surface water may require a new NPDES individual permit, a modification of an existing NPDES permit, or an industrial permit if discharged into an existing sewer system. The latter requires coordination and agreement with the municipality that manages the respective sewer system. Routing ROC streams to existing outfalls requires careful review of potential impacts to existing NPDES permits to determine whether the ROC stream may compromise compliance with effluent discharge water quality requirements and whether further waste stream treatment and/or permit modifications are needed.

SNMPs establish pertinent water quality objectives (WQOs) to protect groundwater quality from potential degradation. Although NPR for irrigation can have the potential to increase salts and other contaminants in groundwater, NPR+ water supplied by SBWR meets the drinking water standard (a secondary maximum contaminant level) for TDS and therefore is not anticipated to degrade groundwater quality. Palo Alto is constructing a new local AWPF to create NPR+ supply, and Sunnyvale may opt for NPR+ supply in the future, further decreasing any risk to groundwater quality from irrigation with recycled water.

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[4] Water reclamation requirements (WRRs) are for GWR specifically

Division of Drinking Water

DDW develops and enforces public health protection requirements contained in the California Code of Regulations (CCR) Title 22 Uniform Water Recycling Criteria. DDW regulations around potable reuse depend on the type of reuse. For NPR, DDW has set increasingly stringent water quality requirements proportionally with the potential for public exposure. For GWR, water quality requirements are more stringent for subsurface injection than for surface spreading. DDW has set a high bar for SWA water quality requirements to protect public health. DDW is currently working on DPR regulations for both RWA and TWA: these regulations are anticipated for release in 2023.

DDW specifies public health requirements for water reuse. Key public health criteria include:

- **Pathogen control**
- **Chemical control**
- **Source control**
- **Monitoring/control**
- **Retention/response time**
- **TMF capacity**

3.2 Non-Potable Reuse (Recycled Water)

Water recycling is a form of resource recovery and can be referred to as NPR when serving non-potable end uses, such as irrigation, landscaping, or industrial processes. Typically, recycled water is treated at a WWTP and sold to recycled water users through a dedicated distribution system, separate from the potable drinking water distribution system and distinguished by using purple-colored pipes.

California regulates the treatment, use, and discharge of recycled water according to CCR Title 22, which addresses environmental health, including water-related issues. Title 22 defines four categories of recycled water based on level of treatment and resulting water quality. The Partner Agencies each produce disinfected tertiary recycled water, which meets Title 22's highest level of treatment for NPR, and distribute recycled water to customers in Santa Clara County. Enhanced NPR, or NPR+, goes beyond the requirements for disinfected tertiary recycled water by blending PR water in order to reduce TDS in the recycled water supply. ***Appendix B-2*** contains more information about NPR regulations.

3.3 Potable Reuse

California's regulations acknowledge five specific types of PR (Figure 3-1), each subject to specific permitting requirements. In many cases, these differences are linked to the existence and size of an environmental buffer. As the buffer diminishes in size—or is eliminated in many direct potable reuse (DPR) scenarios—regulatory requirements for other project components increase.

Environmental buffers provide a myriad of benefits—less stringent wastewater and AWPF treatment requirements (due to the attenuation of contaminants in the environment), dilution to minimize potential chemical contaminant peaks, and/or decreased monitoring requirements due to increased response time.

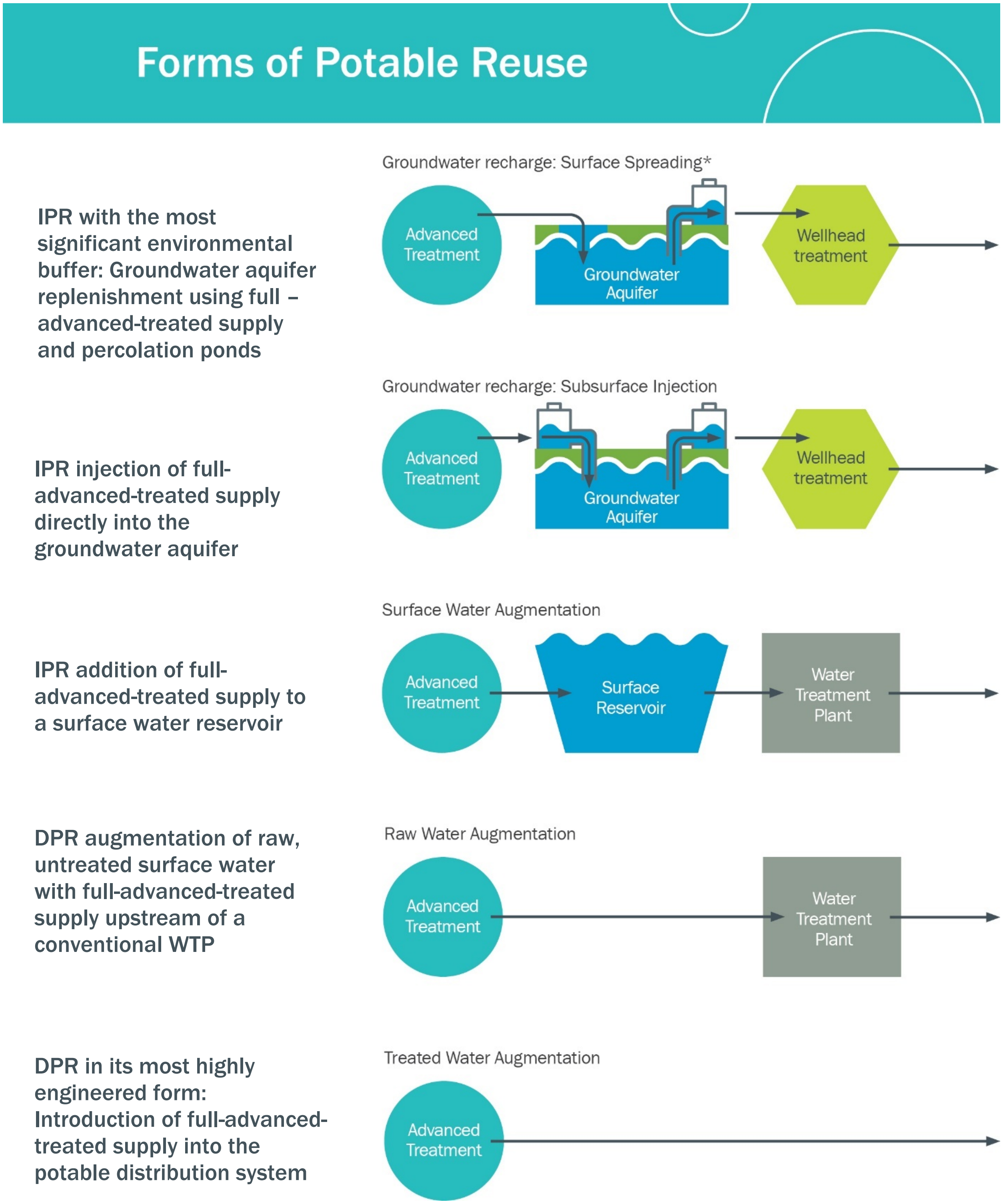
The least-direct form of PR—GWR via surface spreading or direct injection—has been practiced in California the longest, with the first successful indirect potable reuse (IPR) project starting in 1962. More than 50 years later, in 2014, the State finalized GWR regulations.

The extended period between initial GWR implementation and final regulations provided regulators an opportunity to learn how to protect public health while fostering the growth of this alternative water supply. Recently finalized in 2018, SWA regulations developed more quickly, yet still benefited from the lessons learned and process of developing GWR regulations.

In DPR—including both raw water augmentation (RWA) and treated water augmentation (TWA)—the environmental buffer may be significantly reduced or eliminated compared to IPR. Consequently, there may be enhanced requirements for pathogen control, chemical attenuation, real-time monitoring, engineered storage, and blending. Though regulations for RWA and TWA have not yet been developed, potential future requirements can be inferred from DDW's recent publications and presentations, the California DPR Expert Panel, and the Project Team's engagement in DPR research and permitting. An evaluation of regulatory compliance strategy for the portfolios' PR elements is provided in Section 8 of this document, with more detail in ***Appendix B-1***.

Under legislative mandate in Assembly Bill (AB) 574, the State Board is required to develop regulations for RWA by the end of 2023 (with a potential extension to mid-2025). In August 2019, the State Board issued the second edition of its Proposed Framework for Regulating DPR in California, with various updates to their initial draft.

Notably, DDW indicated the intent to develop a single DPR regulatory package that encompasses requirements for both RWA and TWA. The timeline for the DPR regulatory package remains consistent with the AB 574 deadline of December 2023.



Forms of Potable Reuse

IPR with the most significant environmental buffer: Groundwater aquifer replenishment using full – advanced-treated supply and percolation ponds

Groundwater recharge: Surface Spreading*

IPR injection of full-advanced-treated supply directly into the groundwater aquifer

Groundwater recharge: Subsurface Injection

IPR addition of full-advanced-treated supply to a surface water reservoir

Surface Water Augmentation

DPR augmentation of raw, untreated surface water with full-advanced-treated supply upstream of a conventional WTP

Raw Water Augmentation

DPR in its most highly engineered form: Introduction of full-advanced-treated supply into the potable distribution system

Treated Water Augmentation

** Though California regulations allow using tertiary-treated recycled water for groundwater recharge via surface spreading, Valley Water requires full advanced treatment to protect groundwater quality due to the aquifer's limited assimilative capacity for salt.*

Figure 3-1. California regulations address five specific approaches to potable reuse

Section 4:

Existing Reuse Systems

Each of the four WWTPs in the County produces recycled water distributed for NPR. In addition, Valley Water's SVAWPC treats a portion of effluent from the SJ/SC RWF to reduce the salinity of SBWR recycled water and demonstrate advanced treatment technology.

The baseline conditions (physical characteristics and flows) of existing reuse facilities are summarized in the following subsections and inform the analysis of expanded reuse potential. Figure 4-1 shows the extent of each recycled water distribution system.

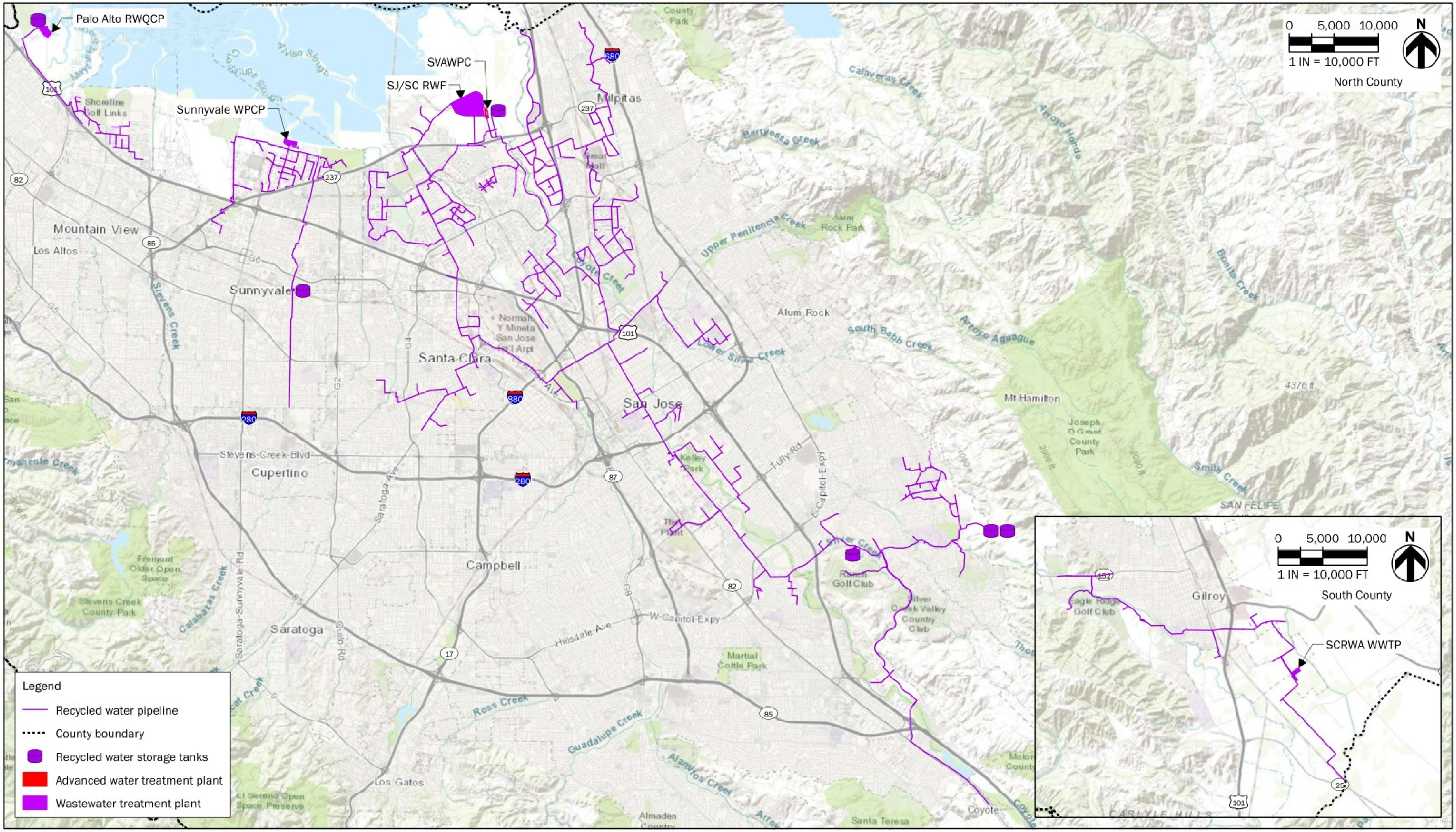


Figure 4-1. Existing recycled water distribution systems throughout Santa Clara County

4.1 System Characteristics

Key characteristics of each WWTP and the corresponding NPR system are summarized below. Many planned improvements—including expanded NPR distribution systems and a new AWPF for NPR+ in Palo Alto—align with the Countywide Master Plan objectives and are being explored in close coordination with Valley Water.

RECYCLED WATER PRODUCERS (WWTPs)

Palo Alto RWQCP

Secondary Treatment
Average influent: 20 mgd*
NPR production capacity: 5 mgd
Planned improvements: secondary treatment process (in construction), solids incinerator, headworks, additional recycled water facilities

Sunnyvale WPCP

Tertiary Treatment
Average influent: 12 mgd*
NPR production capacity: 4 mgd
Planned improvements: replacing primary treatment facilities (in construction), rehabilitating secondary and tertiary facilities, converting secondary treatment to conventional activated sludge process (Phase I in design)

SJ/SC RWF

Tertiary treatment
Average influent: 102 mgd*
NPR production capacity: 38 mgd
Planned improvements: headworks modifications; upgrades to primary and secondary treatment, filtration, and sludge thickening

SCRWA WWTP

Tertiary treatment
Average influent: 6 mgd*
NPR production capacity: 9 mgd
Planned improvements: addition of a new MBR process

RECYCLED WATER SYSTEMS

Palo Alto/Mountain View RWS

Service area: vicinity of Palo Alto RWQCP and North Bayshore area of Mountain View
NPR demands (annual average): 0.6 mgd (2015-2017 average) // 3 mgd (projected**)
Current challenges: high salinity, insufficient storage, no potable backup
Planned improvements: distribution system expansion; AWPF for NPR+

Sunnyvale RWS

Service area: Northern Sunnyvale (north of Highway 237) and Apple campus in Cupertino
NPR demands (annual average): 1 mgd (2015-2017 average) // 2 mgd (projected**)
Current challenges: high salinity, color (green tint), insufficient storage
Planned improvements: none planned

SBWR

Service area: San José, Santa Clara, and Milpitas
NPR demands (annual average): 12 mgd (2015-2017 average) // 28 mgd (2035 projected***)
Current challenges: insufficient storage, lack of isolation valves
Planned improvements: maintenance and reliability upgrades

South County RWS

Service area: Gilroy
NPR demands (annual average): 2 mgd (2015-2017 average) // 3 mgd (projected**)
Current challenges: high salinity, no potable backup, peak hour demands approaching system capacity
Planned improvements: distribution system expansion

PURIFIED WATER FACILITY

Silicon Valley Advanced Water Purification Center (SVAWPC)

Owned and operated by Valley Water, the SVAPWC is located across the street from the SJ/SC RWF in San José. SVAWPC was developed to further enhance the quality of SBWR recycled water. Because the facility employs many of the treatment processes needed for PR, it has also been used to evaluate PR as a future water supply option. The current PR water production capacity is 8.0 mgd.

** 2014-2019 average influent from California Integrated Water Quality System (CIWQS). (Note – values from CIWQS were reduced by 0.5 mgd for Sunnyvale per direction from Sunnyvale staff.)*

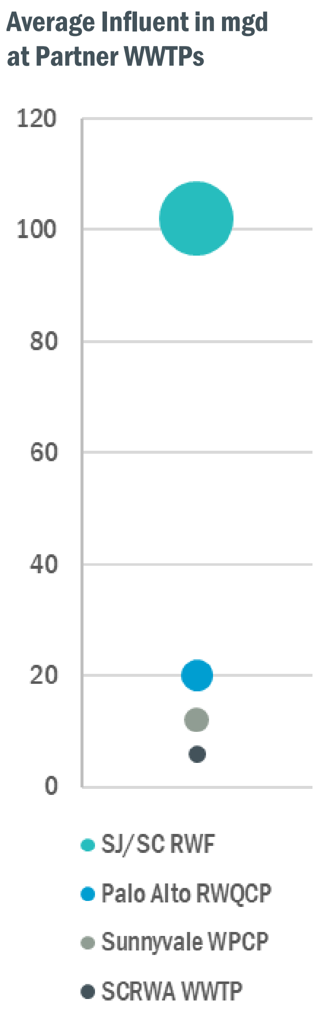
*** 2035 NPR demand projections from 2015 Urban Water Management Plans and rounded to the nearest 1 mgd.*

**** updated 2035 projections provided by SBWR staff in January 2019*

4.2 Existing Flow Conditions

WWTP Influent

Figure 4-2 shows daily influent flows at each of the four WWTPs (2014-2019). Influent varies seasonally, particularly during wet years, with winter flows significantly higher than summer flows. Influent is often characterized as average dry weather flow (ADWF), or the lowest consecutive three-month average, which tends to be much lower than average annual flow.



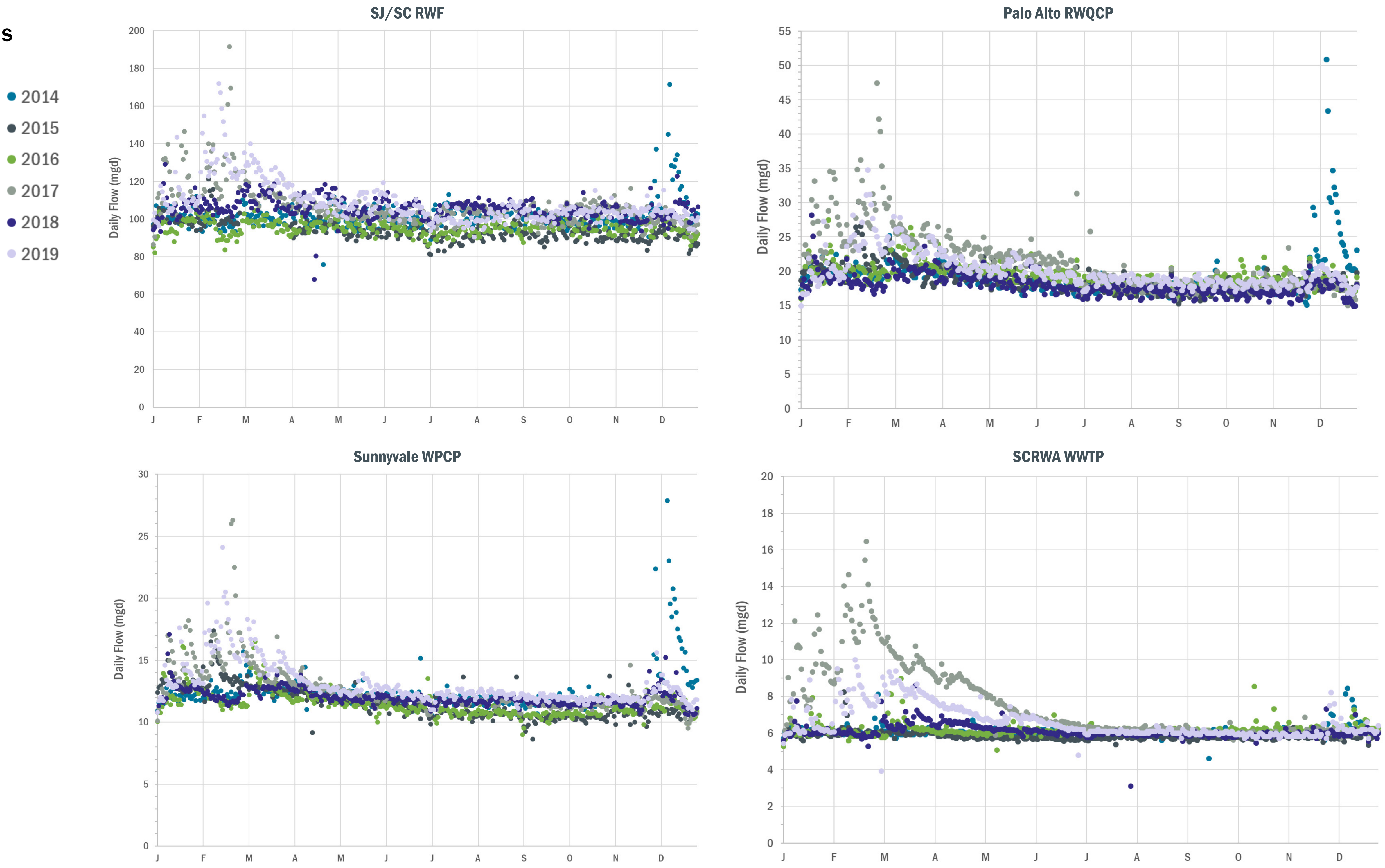


Figure 4-2. Existing flow conditions by Partner Agency, based on average daily WWTP influent flows (2014 through 2019)

Source: California Integrated Water Quality System (CIWQS) database (note – Sunnyvale flows were reduced by 0.5 mgd to more accurately reflect flow into the WPCP, per discussion with Sunnyvale staff).

NPR Demands

Average monthly NPR demands (based on 2015-2017 data provided by Partner Agencies) are shown on Figure 4-3. NPR demand tends to be much higher in summer months, as recycled water is largely used for landscape irrigation. To improve water quality and maintain a target TDS below 500 milligrams per liter (mg/L), SBWR currently blends purified water from the SVAWPC with its Title 22 recycled water, resulting in reuse supply referred to as enhanced NPR, or NPR+. Palo Alto is planning a local AWPF for NPR+ in the future. Sunnyvale and SCRWA currently do not have a need for NPR+.

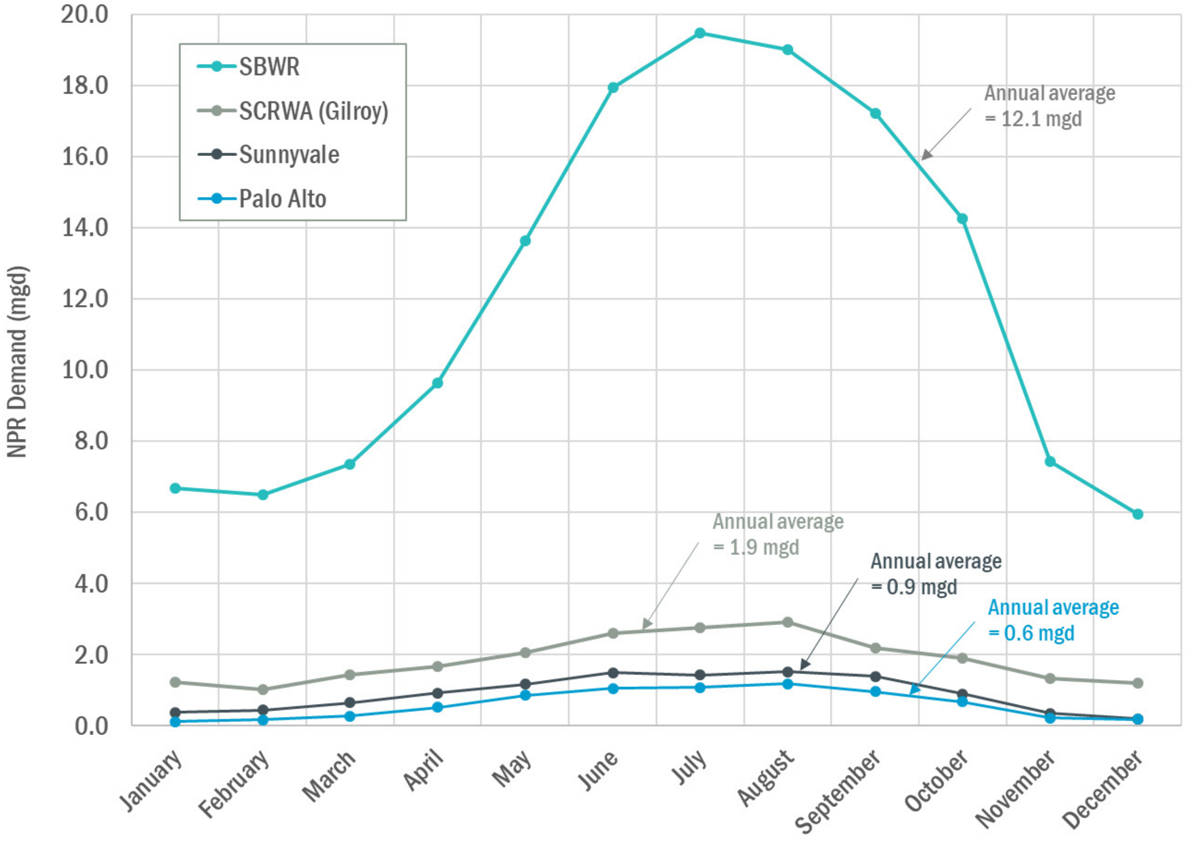


Figure 4-3. Existing NPR demands by Partner Agency, based on average monthly use (2015-2017)

Environmental Flow Requirements

Depending on circumstances, regulatory permits may specify conditions for systems to support ecosystem health by providing environmental flows dictating the quantity, timing, and quality of water flowing to natural systems. Currently, Palo Alto RWQCP is the only WWTP in the county obligated to provide flow for environmental benefit under NPDES permit requirements. While the Palo Alto RWQCP's NPDES permit currently requires 1.0 mgd of effluent to be sent to the Renzel Marsh project, the marsh may be expanded to receive up to 3.0 mgd. This consumptive use further reduces the amount of supply available for reuse.

Losses

Depending on the treatment process, some WWTPs experience losses during treatment. For example, the Palo Alto RWQCP recirculates some effluent for in-plant uses (e.g., wet scrubber water and filter backwash) and experiences a 20 percent loss of the recirculated flow, which equates to approximately 0.3 mgd. Additionally, the Sunnyvale WPCP has some evaporative losses associated with the use of ponds as part of its treatment process. Current evaporative losses are typically between 1 and 2 mgd, though future losses may be up to 4 mgd, including flows for capping and evaporation at their ponds.

4.3 Reuse Research Facilities

In 2014, Valley Water commissioned the SVAWPC, an 8.0-mgd state-of-the-art advanced water treatment facility that includes microfiltration, reverse osmosis (RO), and ultraviolet (UV) light disinfection. A pilot-scale advanced oxidation process is also part of the facility, used to test and demonstrate the continued performance of advanced treatment technologies for producing highly-treated water (purified water) to be used for IPR and/or potential DPR applications. The facility provides an excellent venue for both IPR and DPR public education. The 2015 PR Demonstration Test Plan prepared by Valley Water demonstrated effective performance of the SVAWPC to further advance secondary treated wastewater to meet or exceed California drinking water standards. Figure 4-4 shows key results of this study.

All purification processes exhibited required performance

Removal of pathogens and contaminants of emerging concern (CEC)

Water purified with advanced oxidation meets all California drinking water standards

New ways of monitoring were proven to accurately verify removal of pathogens and contaminants

Critical control points (parameters that will demonstrate water quality that meets regulations) were identified

Staff gained valuable understanding of what changes are important for the future production of purified water

Figure 4-4. Key results of the PR demonstration test plan for SVAWPC

In 2017, Valley Water initiated a ROC Management Project to evaluate viable alternatives for managing ROC from potential advanced water purification facilities that could be built in the County. The ROC Management Project includes evaluating treatment alternatives and discharge options, and installing, testing, and evaluating a pilot-scale engineered open-cell treatment system at the SVAWPC.

Independent of Valley Water's reuse research efforts but still within Santa Clara County, Stanford University is currently operating a water reuse testing and research facility constructed in 2016 called the Codiga Resource Recovery Center. The center has the flexibility to evaluate multiple mobile treatment systems and to vary feed water quality (lake water, greywater, municipal wastewater [raw sewage], primary effluent, and secondary effluent). The flagship treatment technology is a staged anaerobic fluidized bed membrane bioreactor that treats municipal wastewater to secondary effluent water quality standards and converts organic matter to biogas methane. Benefits of this technology include decreased energy use by avoiding aeration and reduced solids handling costs. The center is also evaluating forward osmosis/RO technology first developed by NASA. Currently, all effluent is returned to the sewer for treatment at the Palo Alto RWQCP.

The successful operation of the SVAWPC, along with these advanced technology and research studies, establishes a foundation to provide regional discussions on the feasibility and development of PR projects.

Section 5:

Expanded Reuse Potential

This Master Plan provides insight into improving water supply reliability through water reuse for Santa Clara County. Valley Water's strategy for meeting this goal is twofold: (1) to integrate and expand existing NPR systems, and (2) to develop purified water systems within the County.

5.1 Projected NPR Demands

Expansion of NPR is a key component of the Master Plan, as all four Partner Agencies anticipate increased NPR demand in their service areas. The Master Plan assumes that NPR demands will be met before remaining effluent is made available for potable reuse.

Based on available projections from all four Partner Agencies, 2035 was used as the timeframe for estimating future flow availability. Because water suppliers developed their 2015 Urban Water Management Plans (UWMP) in coordination with recycled water producers, they generally contain the most recent NPR demand forecasts and therefore were used as the basis for future NPR projections with a few exceptions:

- In January 2019, SBWR provided updated recycled water projections that reflect increased NPR+ demand in areas served by the City of Santa Clara and San José Municipal Water.
- Morgan Hill's 2015 UWMP projected zero long-term NPR deliveries; however, because an NPR project in Morgan Hill may be feasible under a more integrated regional context, the Countywide Master Plan uses Morgan Hill's conceptual NPR buildout demands from the 2015 South County Recycled Water Master Plan Update.

Expanded reuse potential—including NPR and PR—was evaluated in partnership with recycled water producers, wholesale and retail water suppliers, end users, regulatory agencies and other interested parties.

NPR demand projections by Partner Agency, as summarized in Table 5-1, do not fully capture potential allocations per contractual agreements. For example, Mountain View is contractually entitled to peak flows of up to 3 mgd of recycled water from Palo Alto, though projected NPR demand is less than 3 mgd when considered over a timeframe beyond peak demands. The Countywide Master Plan assumes future NPR usage aligns with projected demand, though contractual obligations are considered in the context of project feasibility and implementation as they effectively limit the effluent available for PR.

Although future NPR projections are provided as an annual estimate, NPR use varies seasonally. A monthly distribution factor, based on actual NPR data from 2015-2017, was applied to the 2040 projections to estimate future monthly NPR demand.

Table 5-1. Summary of Projected Long-Term NPR Demands by Partner Agency

Partner Agency	Water Retailers	2040 NPR Demand		Current Contractual Obligation [b]
		mgd	AFY[a]	
PA/MV RWS	Palo Alto Mountain View	2.5	2,800	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	Sunnyvale Cal Water (Cupertino) San José Water (Cupertino)	1.5	1,700	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	Santa Clara San José Municipal Water San Jose Water Milpitas	27.6	30,900[c]	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline (through January 22, 2027, unless agreement is extended)
SCRWA	Gilroy Morgan Hill	3.3 2.6	3,700 2,900[d]	(None)
Countywide	**Total, excluding Morgan Hill** **Total, including Morgan Hill**	**34.9** **37.5**	**39,100** **42,000[d]**	

a. *Projected 2035 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY. For the City of Morgan Hill, NPR demand is equal to the conceptual buildout demand identified in the 2015 South County Recycled Water Master Plan Update. Long-term demands assume that any existing NPR is estimated into the future year UWMP demands, if applicable.*

b. *Projected NPR demands do not fully capture potential allocations per contractual agreements.*

c. *Reflects updated 2035 NPR demands provided by SBWR staff in January 2019.*

d. *Reflects Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.*

5.2 Available Source Water for Potable Reuse

In addition to NPR, some WWTP effluent is reserved for other uses, such as for environmental benefit. Figure 5-1 shows a flow balance for typical WWTP that accounts for various flow streams. The Project Team completed a flow balance for each Partner Agency WWTP to estimate the remaining effluent available for discharge, blending, or additional reuse in 2035. Because NPR expansion is already planned by each Partner Agency, the Master Plan assumes projected NPR demands will remain intact, and PR projects will be sourced by remaining effluent (minus any effluent reserved for discharge, blending, or other requirements).

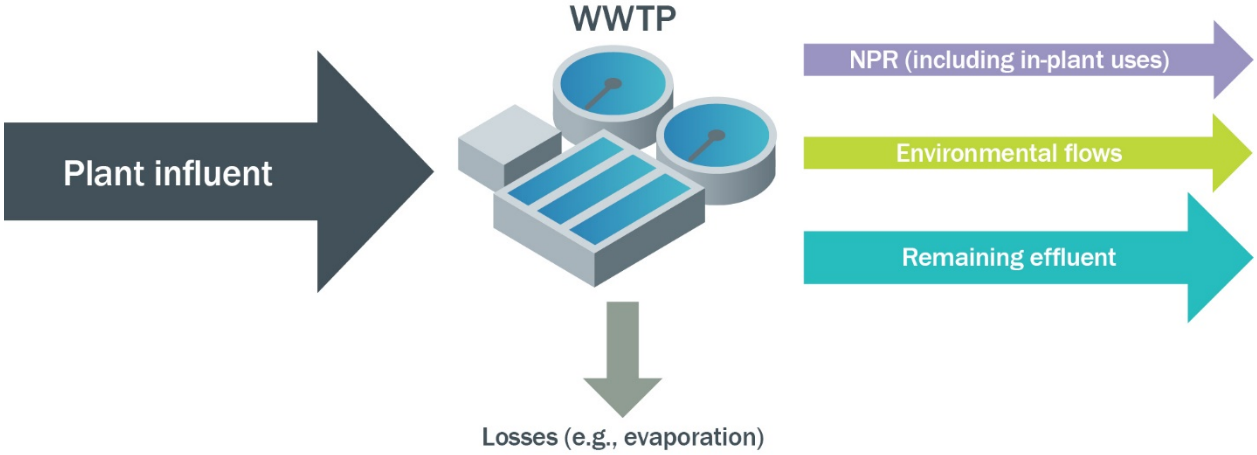


Figure 5-1. Typical WWTP flow balance

INFLUENT
Partner Agencies' wastewater and recycled water master plans were used as the starting point for future plant influent projections, though these projections were adjusted downward to align with baseline conditions (using average monthly median flows, 2014-2018).

To account for uncertainty in future influent projections, a range of flows was considered. The "lower bound" assumes no increase from baseline (flatlined projection through 2035). The "upper bound" assumes same slope (i.e., rate of increase) from Partner Agencies' planning documents.

NPR/NPR+
As described in Section 5.1, retailers' 2015 UWMPs served as the source for projected NPR demand, except for SBWR (whose staff provided updated demands in January 2019) and Morgan Hill (conceptual buildout demand from 2015 South County Recycled Water Master Plan Update). For the three North County systems (SBWR, Palo Alto, and Sunnyvale), additional losses associated with NPR+ (i.e., ROC from advanced treatment) were considered.

ENVIRONMENTAL FLOW REQUIREMENTS
The flow analysis assumed 3 mgd of effluent from the Palo Alto RWQCP will be sent to Renzel Marsh year-round in 2035, based on a potential future expansion project. No environmental flow requirements were identified for the SJ/SC RWF, Sunnyvale WPCP, or SCRWA WWTP.

OTHER LOSSES
In general, treatment losses at the WWTPs were assumed to be negligible, unless otherwise specified by Partner Agency staff. Future losses considered 0.3 mgd lost from recirculated flow at the Palo Alto RWQCP and 4 mgd reserved for evaporation and capping at the Sunnyvale WPCP.

REMAINING EFFLUENT
Remaining effluent (i.e., WWTP influent minus losses, environmental flows, and NPR demands) may be available for discharge, blending, or additional reuse. Currently, remaining effluent in North County is discharged to the San Francisco Bay, while remaining effluent in South County is sent to percolation ponds or discharged to the Pajaro River (and eventually Monterey Bay). For the purpose of this planning-level estimate, it was assumed that all remaining effluent was available for PR, and potential AWPFs were sized accordingly.

Results from the flow analysis are summarized below by Partner Agency. More details on the methodology, data, and assumptions for determining the remaining effluent available for PR and additional details are included in *Appendix A-2*.

5.2.1 SJ/SC RWF Flow Analysis

Figure 5-2 displays future influent projections and effluent needed to meet SBWR's future NPR+ projections through 2035. Because no environmental flows or other losses were identified for the SJ/SC RWF, the difference between the two is the remaining effluent available, which is projected to be 71 to 79 mgd on average. Though some effluent may be needed for discharge, blending, or other uses in the future, the amount available typically exceeds the flow needed to produce 24,000 AFY for PR.

Valley Water's goal of producing 24,000 AFY of purified water for PR can be achieved by a 24-mgd AWPF (assuming a 90% online factor). Though flow varies seasonally, historical influent data suggest the SJ/SC RWF has sufficient effluent to produce 24 mgd of purified water (30.4 mgd, prior to treatment losses), with excess flow available on most days (99.9%), as shown on Figure 5-2.

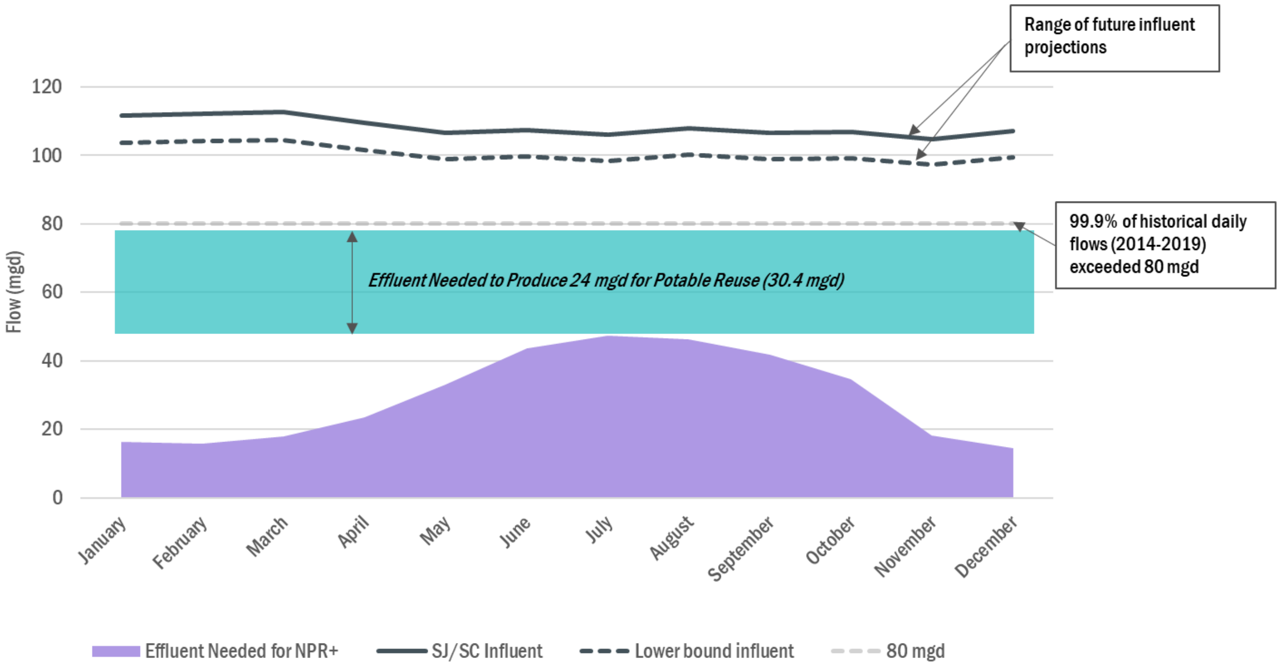


Figure 5-2. Projected flow conditions at SJ/SC RWF considering 2035 future influent projections and SBWR NPR+ demands

Note: Gray dashed line shows average remaining effluent available.

Teal shaded area shows effluent needed to produce 24 mgd of purified water

5.2.2 Palo Alto RWQCP Flow Analysis

Figure 5-3 displays future influent projections, effluent needed to serve Palo Alto and Mountain View NPR+ demands in 2035, environmental flow to Renzel Marsh (3 mgd) and losses (0.3 mgd). The remaining effluent available is projected to be 13.3 to 15.3 mgd on average (based on the range of influent projections).

On its own, the Palo Alto RWQCP does not have sufficient effluent available to produce 24 mgd of purified water. Based on available flows, an AWPF in Palo Alto would be sized at **14 mgd** (84% efficiency under "upper bound" conditions). Under "lower bound" conditions, the AWPF would be downsized to 12 mgd to maintain 84% efficiency. (More details on AWPF sizing and utilization are included in ***Appendix A-2***.

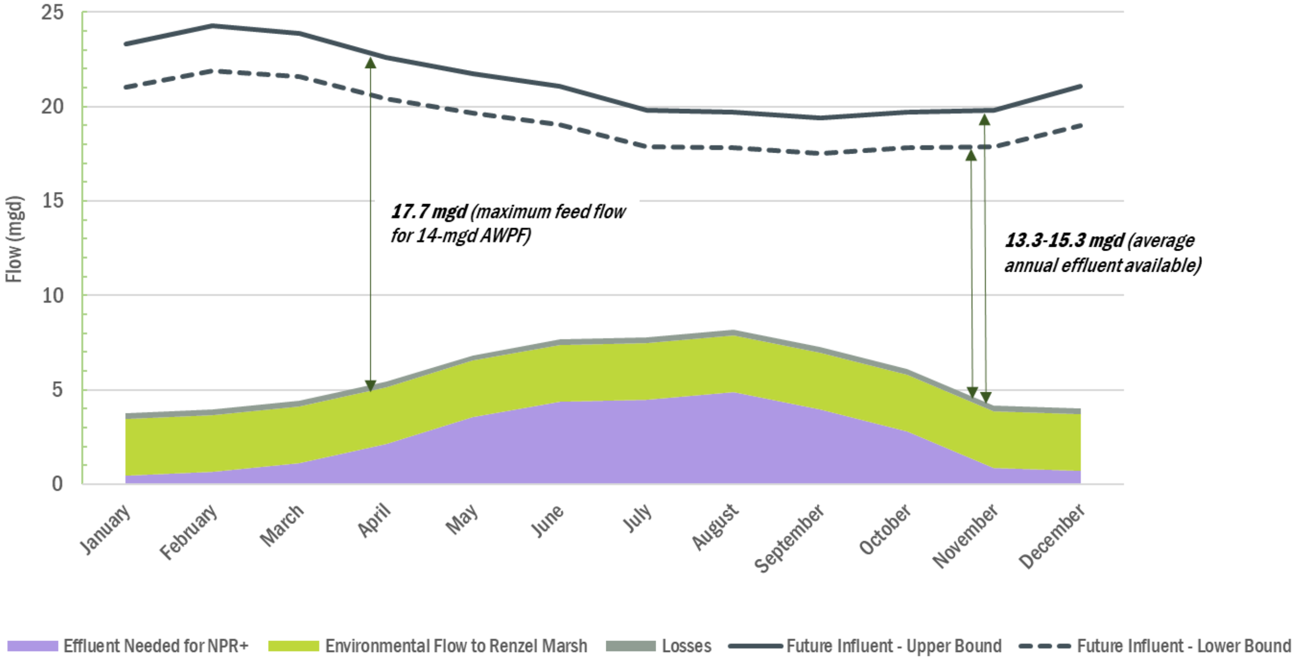


Figure 5-3. Projected flow conditions at Palo Alto RWQCP considering 2035 future influent projections and Palo Alto/Mountain View NPR+ demands

5.2.3 Sunnyvale WPCP Flow Analysis

Figure 5-4 displays future influent projections, effluent needed for NPR+, and losses from evaporation and capping associated with Sunnyvale's treatment ponds (4 mgd). No environmental flow requirements are identified for Sunnyvale WPCP. The remaining effluent available is projected to be at least 5 mgd on average.

On its own, the Sunnyvale WPCP does not have sufficient effluent available to produce 24 mgd of purified water. Based on available flows, an AWPF in Sunnyvale would be sized at 10 mgd (88% efficiency under "upper bound" conditions). Under "lower bound" conditions, the AWPF would be downsized to 6 mgd (81% efficiency).

Under "upper bound" conditions, Sunnyvale and Palo Alto combined could produce 23,000 AFY of purified water for PR (after treatment losses).

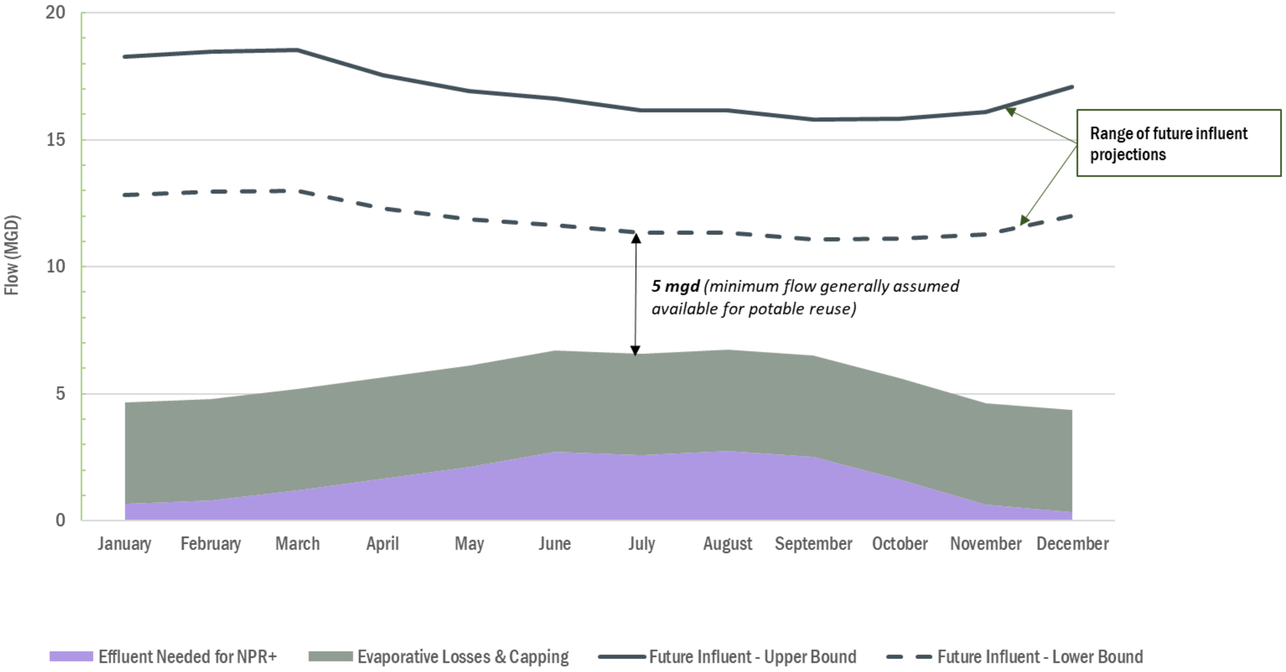


Figure 5-4. Projected flow conditions at Sunnyvale WPCP considering 2035 future influent projections and NPR demands

5.2.4 SCRWA WWTP Flow Analysis

SCRWA WWTP influent remained relatively consistent over the past several years (ADWF = 6 mgd) and is projected to be similar in the future. Unlike the WWTPs in North County, only one set of influent projections was considered for SCRWA.

As shown on Figure 5-5, SCRWA WWTP receives wastewater from two cities: Gilroy and Morgan Hill. Currently, NPR is only delivered in Gilroy. During the summer months, a portion of wastewater from Morgan Hill is needed to supply NPR in Gilroy. On average, 3 mgd of remaining effluent is available from SCRWA WWTP. If considering satellite treatment in Morgan Hill, only 2.1 mgd of Morgan Hill's wastewater would be available on average, assuming some would be needed to supply NPR in Gilroy during the summer months.

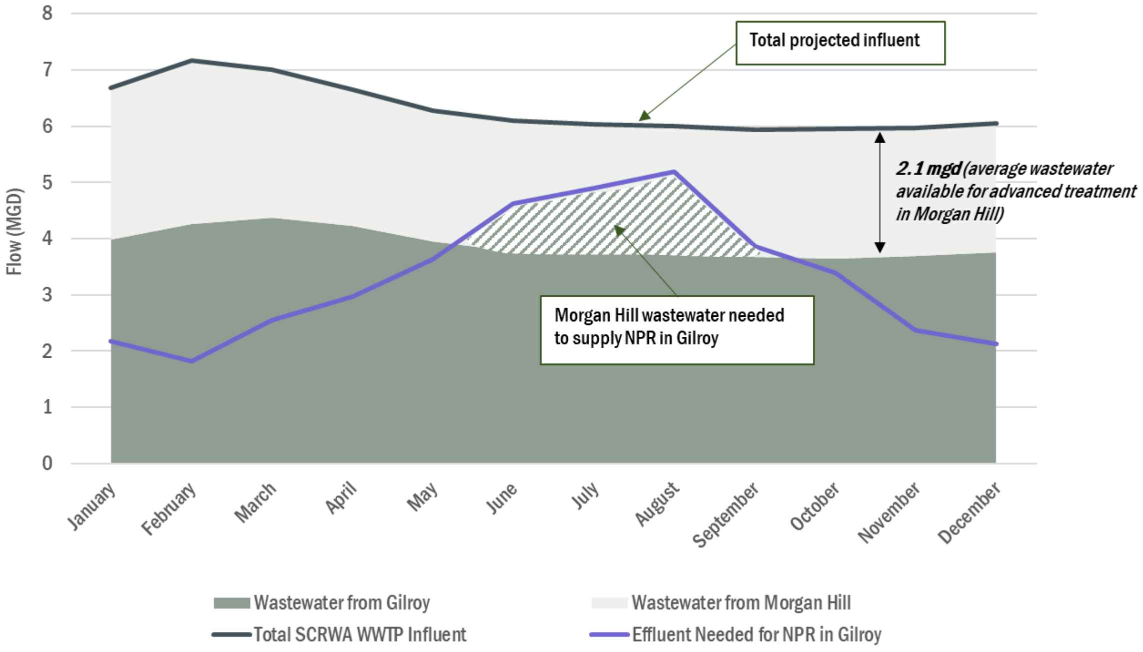


Figure 5-5. Projected flow conditions at SCRWA's WWTP considering 2035 future influent projections and South County RWS NPR demands

5.2.5 Summary

Anticipated purified water yields (after treatment losses) are shown in Table 5-2. These values are based on source water availability and do not account for potential limitations at the delivery point (e.g., groundwater basin capacity), which may limit PR in wet years.

Table 5-2. Annual Yield for Potable Reuse Considering Producer and Source Water Availability

Facility	Anticipated Yield (AFY)
San José AWPF	24,000
Palo Alto AWPF	11,700 – 13,200
Sunnyvale AWPF	5,500 – 9,800
Palo Alto and Sunnyvale (combined)	17,300 – 23,000
Morgan Hill Satellite AWPF	1,900

More details on estimated flows, including summaries of projected monthly flows by Partner Agency and AWPF sizing calculations, are included in *Appendix A-2*.

5.3 Onsite Reuse Consideration

The extent of future onsite non-potable reuse systems (i.e., decentralized building- or neighborhood-scale) in the County may have implications for centralized reuse facilities. While onsite reuse projects can promote public awareness of water reuse and offer potential energy savings, they also reduce the amount of wastewater available for potable reuse and could lead to higher solids concentrations in sewers. Four onsite reuse projects are under development in Mountain View, with potential additional projects being explored elsewhere in the County. Future onsite reuse efforts will require coordination among multiple stakeholders, including Valley Water and the Partner Agencies, to evaluate potential impacts on the Countywide Master Plan. The next iteration of this document (the Draft Final Countywide Water Reuse Master Plan) will include the Project Team's assessment of onsite reuse implications.

Section 6:

Project Portfolios

The Countywide Master Plan refers to groups of project elements (advanced treatment facilities and conveyance infrastructure) in the North County as portfolios and in the South County as options. The distinction in nomenclature is a nod to the flexibility of potentially combining a South County option with any North County portfolio. The process of defining the portfolios and options was iterative and collaborative, as described in this section and in more detail in *Appendix A-1* (Feasible Project Portfolios).

6.1 Conceptual Alternatives/Portfolios

Beginning in 2018, the Project Team created groups of projects and packaged them into five conceptual portfolios (formerly called alternatives) that are consistent with guiding principles agreed upon by the Valley Water and Partner Agencies, including:

1) Leverage existing infrastructure where possible

2) Reflect a mix of NPR/NPR+ and PR projects, including potential TWA concepts as a point of comparison for cost-effectiveness

3) Expand Countywide reuse (NPR and/or PR) using source water from each Partner Agency

4) Consider previously explored projects (but not previously deemed infeasible, unless circumstances have changed) and new projects

5) Aim to develop at least 24,000 AFY (approximately 21.4 mgd) of PR supply by 2028 to meet the County's water supply demands (consistent with Valley Water's 2019 WSMP 2040)

Rather than recommending a single alternative, this Countywide Master Plan takes a holistic look at reuse opportunities; considers their respective feasibility; and evaluates their benefits, challenges, risks, and costs relative to one another.

In coordination with Valley Water and its Partner Agencies, the Project Team evaluated the five conceptual portfolios and narrowed down to three portfolios, defined by AWPF source water and location, to develop through preliminary design and comparatively evaluate based on key attributes, differentiators, and factors critical to feasibility of future implementation.

Five Portfolios Conceptually Explored →

The Partner Agencies developed and assessed five conceptual portfolios.

Evaluation criteria included economics, groundwater management and Countywide (regional) supply reliability, environmental impacts/benefits and sustainability, ease of implementation and permitting/regulatory considerations, and engineering feasibility.

Three Portfolios Selected

Three portfolios feature a variety of project elements developed through preliminary design and evaluated for feasibility. Defined by source of supply and treatment facility location, the three portfolios include:

Portfolio 1: San José AWPF

Portfolio 2: Combined Palo Alto/Sunnyvale Regional AWPF

Portfolio 4: Separate Palo Alto and Sunnyvale AWPFs

Appendix F (Conceptual Alternatives TM) describes in detail the process of developing and assessing the five conceptual portfolios. After narrowing from five to three portfolios, the Project Team developed preliminary (10%) designs for each portfolio, including some permutations, and added new project elements, including different options for South County and potential future TWA concepts. North County portfolios and South County options are described in this section, and all other elements are described in Section 7.

6.2 Feasible Portfolios

The programmatic approach for the Master Plan considers a wide range of reuse opportunities for flexible implementation. Project elements, including AWPFs and conveyance/distribution infrastructure, can be combined in a variety of ways to create Countywide reuse portfolios for comparison on an economic, regulatory, institutional, and environmental basis. Project elements are presented and evaluated in groups:

- **NPR/NPR+ distribution system expansion** applies consistently across all portfolios, and therefore is not considered as a differentiator in the portfolio evaluation.
- **South County reuse options** can be included in combination with any portfolio, and therefore are evaluated separately from the portfolios.
- **Baseline elements** comprise each portfolio and are evaluated collectively by portfolio.
- **Alternative elements** are options that have been explored and remain separate from portfolios, as possible "add-on" items or substitutions (e.g., alternative alignments). These elements are included for consideration due to their potential benefits, though they are not included in the evaluation, which focuses on comparing the differences among portfolios. Alternative elements are described in Section 7.

All AWPFs involve treatment using reverse osmosis membranes, resulting in the production of ROC. ROC management strategies for each AWPF are summarized following each portfolio. An overview of North County portfolios and South County options is shown below with key highlights included in the following subsections. Additional detail (including preliminary designs and cost estimates) is presented in ***Appendix A***.

NPR/NPR+ (Recycled Water) Distribution System Expansion

PROJECT PORTFOLIOS

North County Portfolios

Portfolio 1 **San José AWPF**	1a GWR via LGRP	1b RWA via Penitencia WTP	1c TWA deliveries to Santa Clara, San José, and Valley Water retailers (existing pipeline)	1d TWA deliveries to Santa Clara, San José, and Valley Water retailers (new pipeline)
Portfolio 2 **Combined Palo Alto and Sunnyvale Regional AWPF**	2a Combined AWPF in Palo Alto for GWR via LGRP	2b Combined AWPF in Sunnyvale for GWR via LGRP		
Portfolio 4 **Separate Palo Alto and Sunnyvale AWPFs**	4 Separate AWPF (1 of 2) in Palo Alto for GWR via LGRP	4 Separate AWPF (2 of 2) in Sunnyvale for GWR via LGRP		

ADDITIONAL OPTIONS

South County Options

Morgan Hill Option 1:
NPR+ from SBWR

Morgan Hill Option 2:
Satellite AWPF
for GWR

Morgan Hill Option 3:
Satellite AWPF
for SWA

Alternative Elements

Alternative pipeline alignments, interties, and delivery points. Resized designs. Additional TWA opportunities.

6.2.1 Portfolio 1 – San José AWPF

Portfolio 1 is centered on using available effluent from the SJ/SC RWF to feed a new AWPF adjacent to the existing SVAWPC. ROC management assumptions are described below the portfolio highlights.

Key features and costs for Portfolios 1a, 1b, 1c, and 1d are summarized in Tables 6-1 to 6-4, while Figures 6-1 to 6-4 show their respective facility locations and pipeline alignments.

Table 6-1. Portfolio 1a Key Features and Costs

Portfolio 1a Highlights: 1 AWPF located in San José and used for GWR	**Total Capital Cost:** $650M* **Total Annual O&M Cost:** $20.2M* **Unit Cost, 30-Year Lifecycle:** $2,500-$3,100/AF* **Unit Cost, 100-Year Lifecycle:** $2,000-$2,500/AF* **Reuse Type & Delivery Point:** GWR at LGRP **Projected 2040 Yield:** 19,000-24,000 AFY **AWPF Design Capacity:** 24 mgd in San José **Pipeline Length/Diameter:** 0.4 miles of 60-inch; 18.1 miles of 48-inch	**BENEFITS** Flows from SJ/SC RWF do not limit projected yield. Staff from existing SVAWPC could potentially support new AWPF operation due to proximity. **LIMITATIONS** There is no long-term agreement between Valley Water and San José securing SJ/SC RWF effluent. LGRP recharge potential may limit future yield.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

Table 6-2. Portfolio 1b Key Features and Costs

Portfolio 1b Highlights: 1 AWPF located in San José and used for RWA	**Total Capital Cost:** $635M* **Total Annual O&M Cost:** $20.7M **Unit Cost, 30-Year Lifecycle:** $2,600-$3,000/AF* **Unit Cost, 100-Year Lifecycle:** $2,100-$2,500/AF* **Reuse Type & Delivery Point:** RWA at Penitencia WTP **Projected 2040 Yield:** 19,800-24,000 AFY **AWPF Design Capacity:** 24 mgd in San José **Pipeline Length/Diameter:** 0.4 miles of 60-inch; 8.9 miles of 48-inch	**BENEFITS** Flows from SJ/SC RWF do not limit projected yield. Purified water would be delivered to Penitencia WTP for RWA. Existing infrastructure would largely support operational flexibility allowing delivery to LGRP or Rinconada (with additional costs for improvements needed to connect existing systems). **LIMITATIONS** There is no long-term agreement between Valley Water and San José securing effluent.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

Table 6-3. Portfolio 1c Key Features and Costs

Portfolio 1c Highlights: 1 AWPF located in San José and used for TWA	**Total Capital Cost:** $555M* **Total Annual O&M Cost:** $23.2M* **Unit Cost, 30-Year Lifecycle:** $2,500/AF* **Unit Cost, 100-Year Lifecycle:** $2,100/AF* **Reuse Type & Delivery Point:** TWA **Projected 2040 Yield:** 24,000 AFY **AWPF Design Capacity:** 24 mgd in San José **Pipeline Length/Diameter:** 0.4 miles of 60-inch; 3.9 miles of 36-inch; 4.7 miles of 24-inch	BENEFITS Flows from SJ/SC RWF do not limit projected yield. Water could be delivered to northern parts of Santa Clara and San José and Valley Water's retailers along the Milpitas Pipeline (flowing south) and the East Pipeline. LIMITATIONS There is no long-term agreement between Valley Water and San José securing effluent. Existing infrastructure would largely support operational flexibility allowing delivery to LGRP or Rinconada (with additional costs for improvements needed to connect existing systems). Also, this portfolio does not allow independent use of the Milpitas intertie.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

Table 6-4. Portfolio 1d Key Features and Costs

Portfolio 1d Highlights: 1 AWPF located in San José and used for TWA	**Total Capital Cost:** $605M* **Total Annual O&M Cost:** $23.2M* **Unit Cost, 30-Year Lifecycle:** $2,600/AF* **Unit Cost, 100-Year Lifecycle:** $2,200/AF* **Reuse Type & Delivery Point:** TWA **Projected 2040 Yield:** 24,000 AFY **AWPF Design Capacity:** 24 mgd in San José **Pipeline Length/Diameter:** 0.4 miles of 60-inch; 8.2 miles of 36-inch; 4.7 miles of 24-inch	BENEFITS Flows from SJ/SC RWF do not limit projected yield. Water could be delivered to northern parts of Santa Clara and San José and Valley Water's retailers along the Milpitas Pipeline (flowing north) and the East Pipeline. LIMITATIONS There is no long-term agreement between Valley Water and San José securing source water. Existing infrastructure would largely support operational flexibility allowing delivery to LGRP or Rinconada (with additional costs for improvements needed to connect existing systems).

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

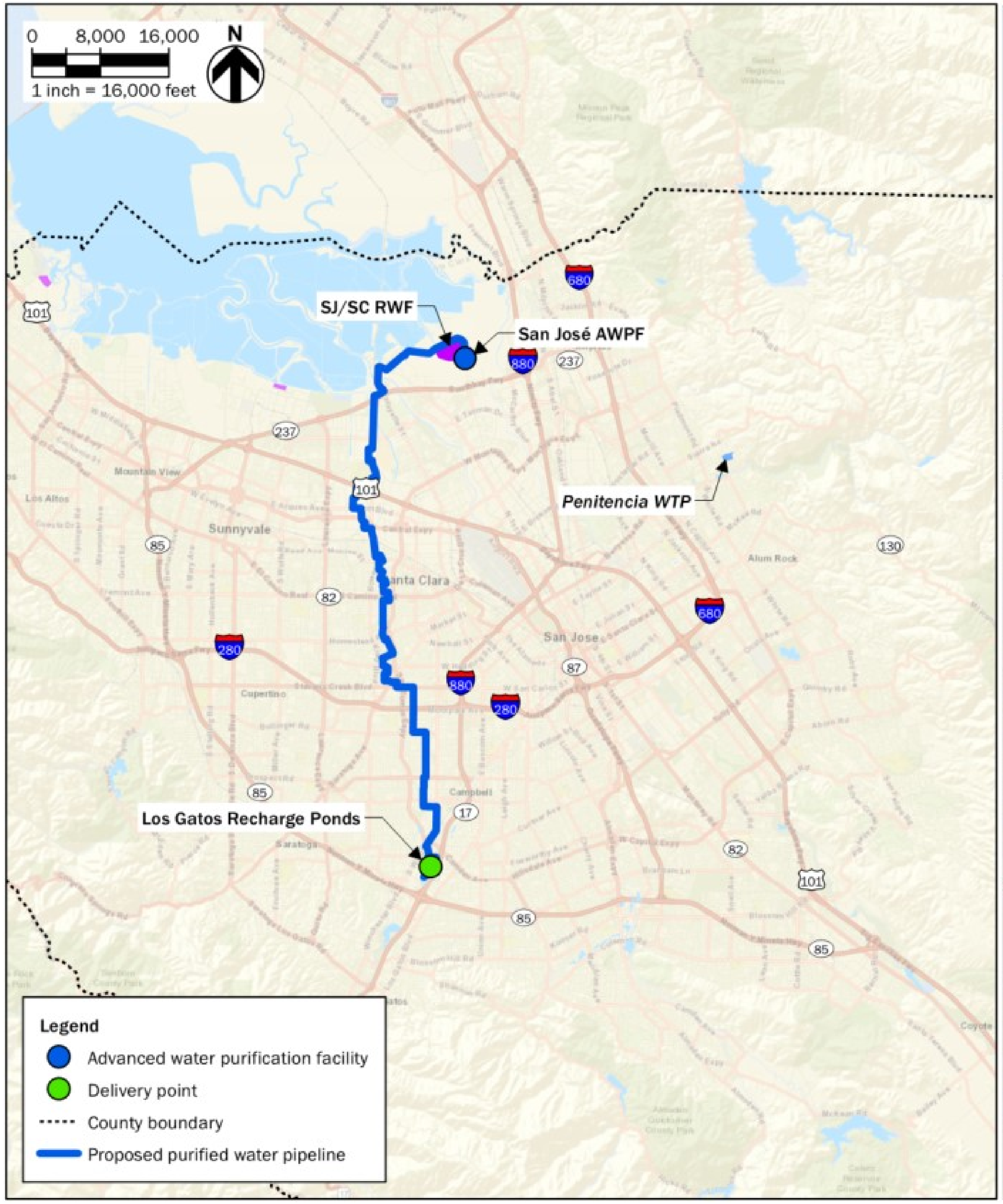


Figure 6-1. Facility locations and pipeline alignments for Portfolio 1a (San José AWPF, GWR at LGRP)

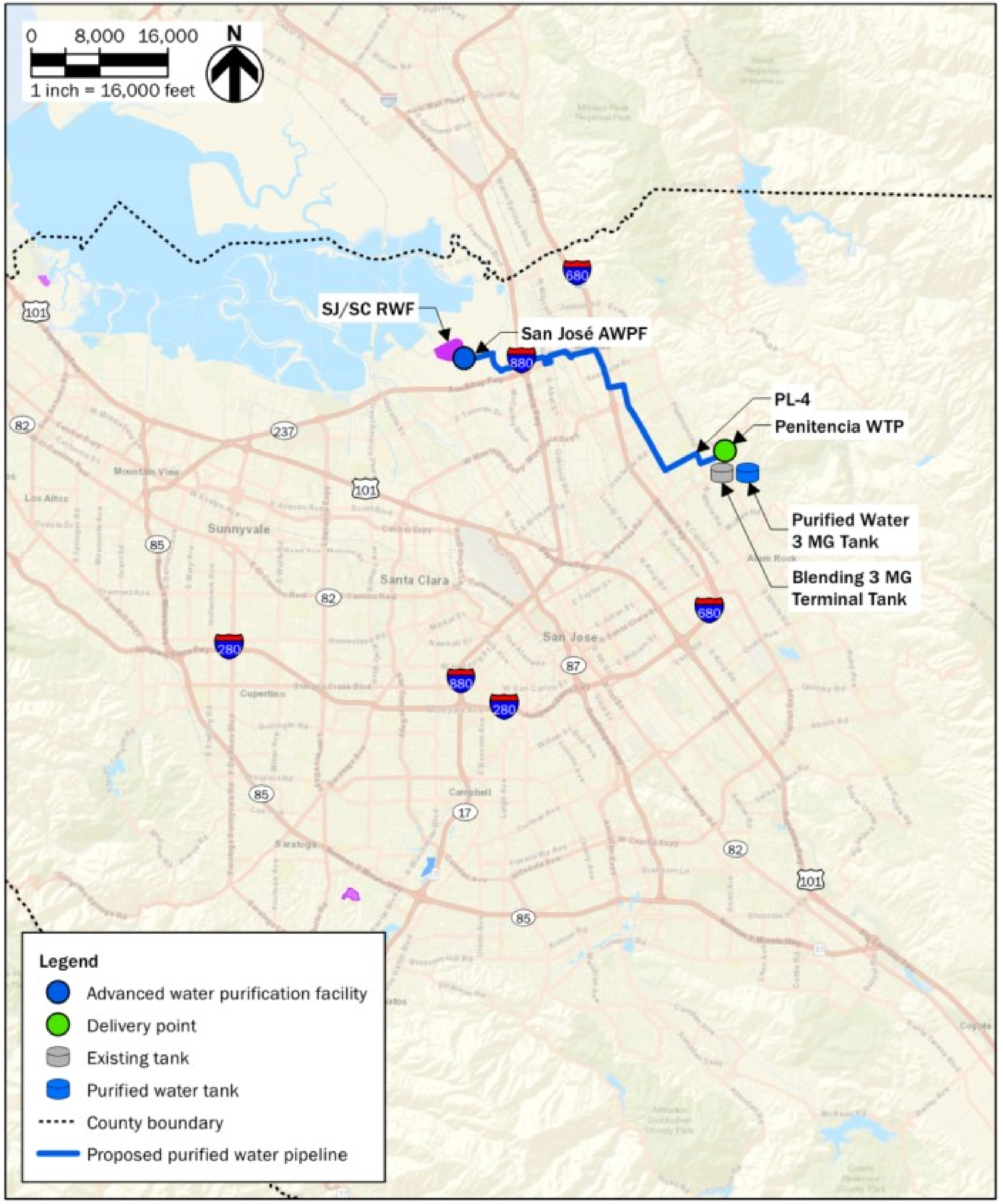


Figure 6-2. Facility locations and pipeline alignments for Portfolio 1b (San José AWPF, RWA at Penitencia WTP)

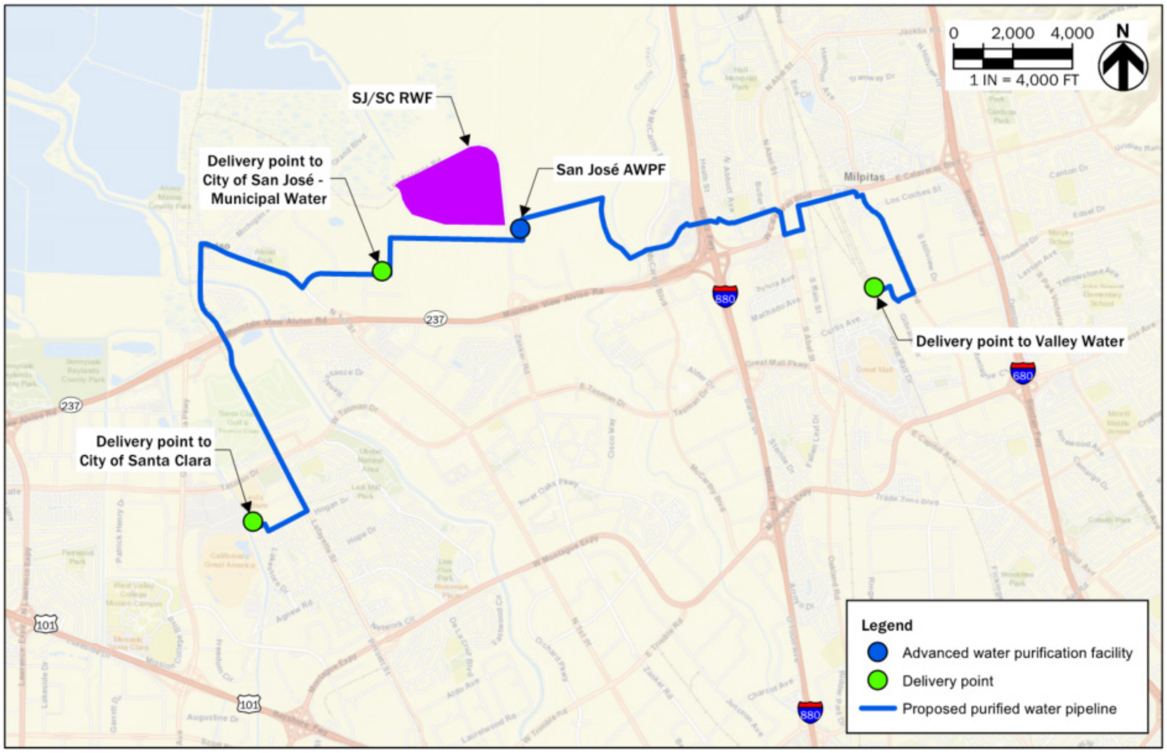
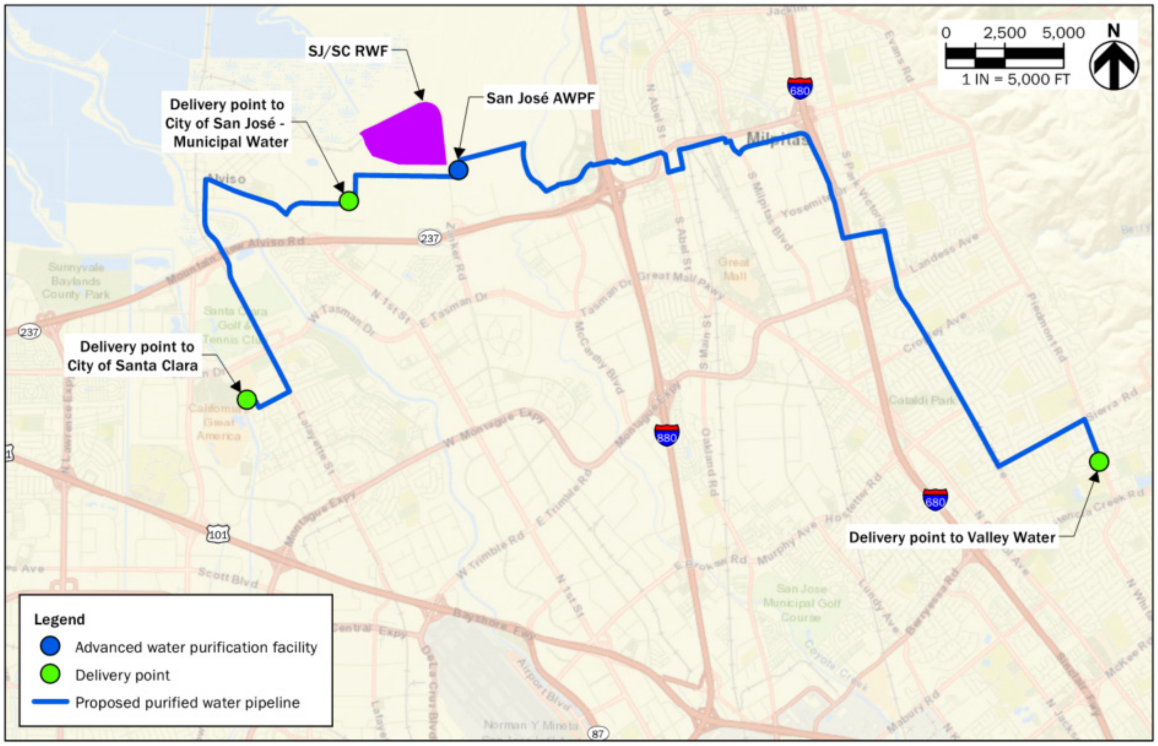

0 2,000 4,000
1 IN = 4,000 FT
N
SJ/SC RWF
Delivery point to City of San José - Municipal Water
San José AWPF
Milpitas
Delivery point to Valley Water
Delivery point to City of Santa Clara
237
880
680
101
Legend
Advanced water purification facility
Delivery point
Proposed purified water pipeline

Figure 6-3. Facility locations and pipeline alignments for Portfolio 1c (San José AWPF TWA, Milpitas Pipeline)


0 2,500 5,000
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SJ/SC RWF
Delivery point to City of San José - Municipal Water
San José AWPF
Milpitas
Alviso
Delivery point to City of Santa Clara
Delivery point to Valley Water
237
680
880
101
87
Legend
Advanced water purification facility
Delivery point
Proposed purified water pipeline

Figure 6-4. Facility locations and pipeline alignments for Portfolio 1d (San José AWPF TWA, new pipeline)

Each variation of the San José AWPF is estimated to produce up to 4.3 mgd of ROC. Valley Water's ROC Management Team identified two options for managing ROC from the San José AWPF portfolios:

- PORTFOLIO 1, ROC OPTION 1: Blending and discharge at a new outfall downstream of existing effluent outfall discharge weir. This option involves constructing a ROC pump station and holding tank, 1.8 miles of 18-inch HDPE pipe from the AWPF to a new outfall near the existing effluent weir, and an outfall diffuser at the discharge point. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.
- PORTFOLIO 1, ROC OPTION 2: Discharge at a new shallow outfall at Coyote Creek. This option involves constructing a ROC pump station and holding tank, 3.8 miles of 18-inch HDPE pipe from the AWPF to a new outfall at Coyote Creek, and an outfall diffuser at the discharge point. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.

The Draft Countywide Master Plan uses ROC management option 1 for a San José AWPF as a placeholder for estimating costs.

IMPORTANT NOTE: The ROC management strategies and identified solution for each portfolio/option are outdated. (At the time of developing this Draft Countywide Master Plan, the Project Team relied upon GHD's TM dated March 6, 2020 entitled *Task 5 – Basis of Cost Estimates for ROC*.) Valley Water's ROC Management Team is separately developing ROC management strategies, and findings from their work will be integrated into the Draft Final Countywide Master Plan in fall 2020.

6.2.2 Portfolio 2 – Combined Palo Alto/Sunnyvale Regional AWPF

Portfolio 2 is centered around combining available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for treatment at one AWPF that would provide regional benefit through GWR at LGRP. Sourcing one AWPF from two WWTPs (operated by two separate agencies) is not common and would likely involve unique interagency and regulatory circumstances. In addition, source flow availability is a key consideration for a Palo Alto and Sunnyvale-based portfolio, as total combined WWTP influents may not be sufficient to meet Valley Water's 24,000 AFY PR goal. Two options were evaluated, and both are designed to deliver up to 23,000 AFY to LGRP for GWR.

Key features and costs for Portfolios 2a and 2b are summarized in Tables 6-5 to 6-6, while Figures 6-5 to 6-6 show their respective facility locations and pipeline alignments.

Table 6-5. Portfolio 2a Key Features and Costs

Portfolio 2a Highlights: 1 AWPF located in Palo Alto and used for GWR	**Total Capital Cost:** $770M* **Total Annual O&M Cost:** $21.0M* **Unit Cost, 30-Year Lifecycle:** $2,900-$3,800/AF* **Unit Cost, 100-Year Lifecycle:** $2,300-$3,000/AF* **Reuse Type & Delivery Point:** GWR at LGRP **Projected 2040 Yield:** 17,000-23,000 AFY **AWPF Design Capacity:** 24.5 mgd in Palo Alto; including 0.5 mgd for NPR+ in Sunnyvale **Pipeline Length/Diameter:** 20.3 miles of 48-inch, 10.3 miles of 36-inch	**BENEFITS** Valley Water has a long-term agreement with Palo Alto to receive flows and is in discussions with Sunnyvale. **LIMITATIONS** Flows from Palo Alto RWQCP and Sunnyvale WPCP limit projected yield.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

Table 6-6. Portfolio 2b Key Features and Costs

Portfolio 2b Highlights:

1 AWPF located in Sunnyvale and used for GWR

Total Capital Cost: $795M*

Total Annual O&M Cost: $20.2M

Unit Cost, 30-Year Lifecycle: $2,900-$3,800/AF*

Unit Cost, 100-Year Lifecycle: $2,300-$3,000/AF*

Reuse Type & Delivery Point: GWR at LGRP

Projected 2040 Yield: 17,000-23,000 AFY

AWPF Design Capacity: 24.5 mgd in Sunnyvale; including 0.5 mgd for NPR+ in Sunnyvale

Pipeline Length/Diameter: 17.1 miles of 48-inch;10.0 miles of 36-inch

BENEFITS

Valley Water has a long-term agreement with Palo Alto to receive flows and is in discussions with Sunnyvale.

LIMITATIONS

Flows from Palo Alto RWQCP and Sunnyvale WPCP limit projected yield. Technical feasibility and extent of costs related to site preparation to construct an AWPF at the parcel next to Sunnyvale's WPCP, Recycle Hill (a former landfill site) remain in question. However, due to lack of available land, Recycle Hill is the site assumed for preliminary design purposes, and best available information is included to reflect potential site preparation costs. In addition, ROC management options are limited and less feasible compared to other reuse opportunities and AWPF locations.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

Portfolio 2a would produce up to 4.3 mgd of ROC. Valley Water's ROC Management Project Team identified three options for managing ROC from the Palo Alto Regional AWPF, Portfolio 2a:

- PORTFOLIO 2a, ROC OPTION 1: Blending and discharge at the existing RWQCP outfall. This option involves constructing a ROC pump station and holding tank and 2.1 miles of 18-inch HDPE pipe from the AWPF to the existing outfall. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.
- PORTFOLIO 2a, ROC OPTION 2: Discharge at a new shallow outfall in San Francisco Bay. This option involves constructing a ROC pump station and holding tank, 2.8 miles of 18-inch HDPE pipe from the AWPF to the existing outfall, and 0.2 miles of 18-inch HDPE pipe from the existing outfall to a location under San Francisco Bay. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.
- PORTFOLIO 2a, ROC OPTION 3: Discharge at a deep-water outfall north of Dumbarton Bridge. This option involves constructing a ROC pump station and holding tank and 13.3 miles of 20-inch HDPE pipe from the AWPF to an existing deep-water outfall in Redwood City. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.

The Master Plan assumes use of Option 1 for ROC management at the Palo Alto AWPF as a placeholder for estimating costs.

Portfolio 2b would produce up to 4.3 mgd of ROC. Valley Water's ROC Management Project Team identified a single option for managing ROC from the Sunnyvale Regional AWPF, Portfolio 2b:

- PORTFOLIO 2b, ROC OPTION: Discharge at a new shallow outfall at Guadalupe Slough. Involves constructing a ROC pump station, holding tank, and 6.2 miles of 18-inch HDPE pipe from the AWPF to a new outfall discharge at Guadalupe Slough. ROC management cost estimate includes treatment processes for nutrients and CECs.

IMPORTANT NOTE: The ROC management strategies and identified solution for each portfolio/option are outdated. (At the time of developing this Draft Countywide Master Plan, the Project Team relied upon GHD's TM dated March 6, 2020 entitled *Task 5 – Basis of Cost Estimates for ROC*.) Valley Water's ROC Management Team is separately developing ROC management strategies, and findings from their work will be integrated into the Draft Final Countywide Master Plan in fall 2020.

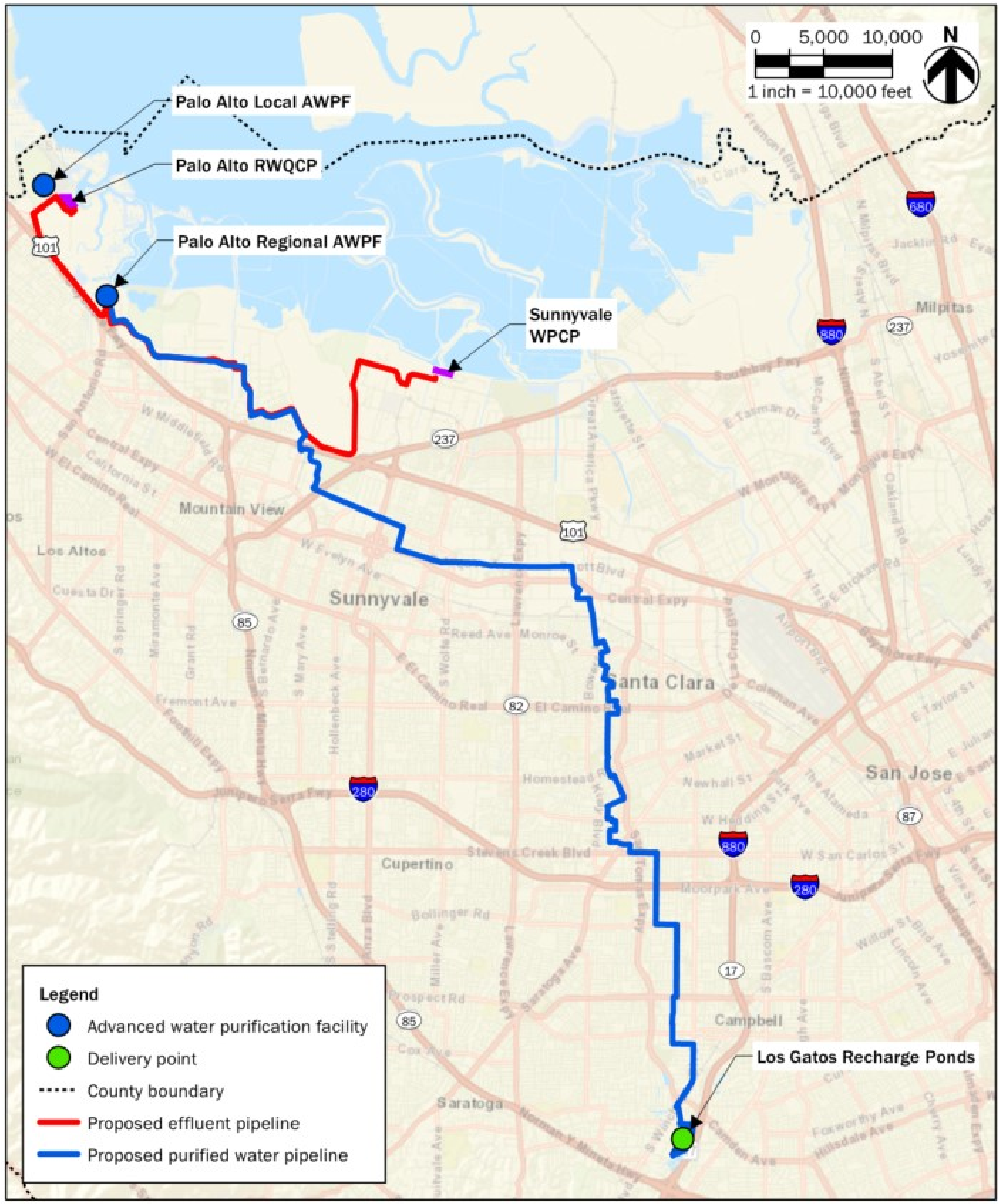


Figure 6-5. Facility locations and pipeline alignments for Portfolio 2a (combined regional AWPF in Palo Alto for GWR at LGRP)

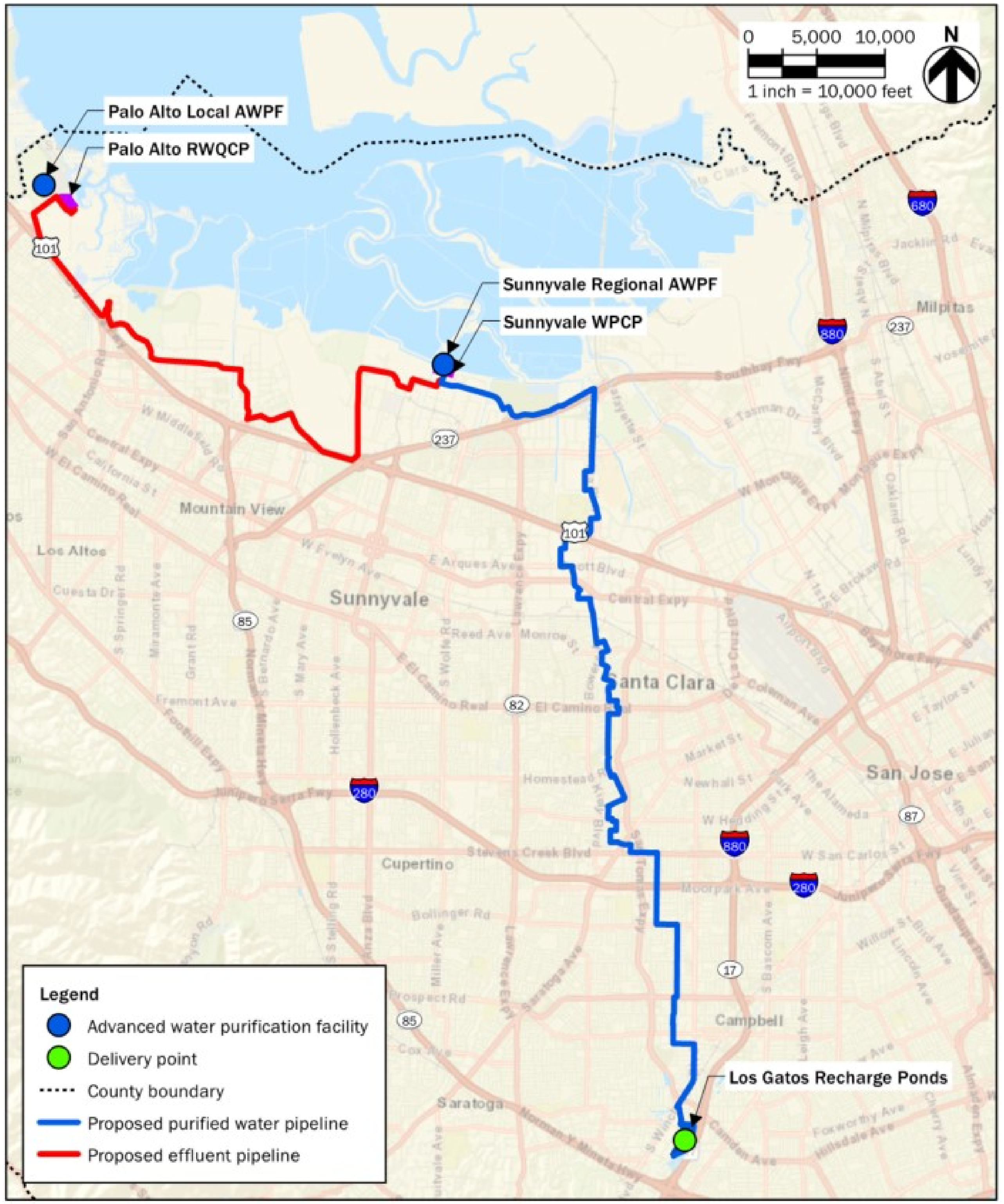


Figure 6-6. Facility locations and pipeline alignments for Portfolio 2b (combined regional AWPF in Sunnyvale for GWR at LGRP)

6.2.3 Portfolio 4 – Separate Palo Alto and Sunnyvale AWPFs

Portfolio 4 is centered on using available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for GWR at the LGRP. In this portfolio, two AWPFs would be constructed to use available flow from each WWTP. The Sunnyvale AWPF would be located on Recycle Hill, and the Palo Alto facility would be on the former Los Altos Treatment Plant site located in Palo Alto.

Key features and costs for Portfolio 4 are summarized in Tables 6-7, while Figures 6-7 shows its respective facility locations and pipeline alignments.

Table 6-7. Portfolio 4 Key Features and Costs

Portfolio 4 Highlights: 2 AWPFs used for GWR: 1 located in Palo Alto, 1 located in Sunnyvale	**Total Capital Cost:** $815M* **Total Annual O&M Cost:** $21.9M* **Unit Cost, 30-Year Lifecycle:** $3,100-4,100/AF* **Unit Cost, 100-Year Lifecycle:** $2,400-$3,200/AF* **Reuse Type & Delivery Point:** GWR at LGRP **Projected 2040 Combined Yield:** 17,000-23,000 AFY **AWPF Design Capacity:** 14 mgd in Palo Alto and 10 mgd in Sunnyvale **Pipeline Length/Diameter:** 13.7 miles of 48-inch; 11.6 miles of 36-inch	**BENEFITS** Valley Water has a long-term agreement with Palo Alto. Having two AWPFs allows Valley Water to build one facility first and the other if and when needed. **LIMITATIONS** Flows from Palo Alto and Sunnyvale limit projected yield. Constructing and operating two separate AWPFs is costly. Technical feasibility and extent of costs related to site preparation to construct an AWPF at the parcel next to Sunnyvale's WPCP, Recycle Hill (a former landfill site) remain in question. However, due to lack of available land, Recycle Hill is the site assumed for preliminary design purposes, and best available information is included to reflect potential site preparation costs.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

Portfolio 4 would produce up to 2.5 mgd of ROC from the Palo Alto AWPF. Valley Water's ROC Management Project Team identified three options for managing ROC from the Palo Alto facility:

- PORTFOLIO 4, PALO ALTO ROC OPTION 1: Blending and discharge at the existing RWQCP outfall. This option involves constructing a ROC pump station and holding tank and 2.1 miles of 14-inch HDPE pipe from the AWPF to the existing outfall. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.
- PORTFOLIO 4, PALO ALTO ROC OPTION 2: Discharge at a new shallow outfall in San Francisco Bay. This option involves constructing a ROC pump station and holding tank, 2.8 miles of 14-inch HDPE pipe from the AWPF to the existing outfall, and 0.2 miles of 18-inch HDPE pipe from the existing outfall to a location under San Francisco Bay. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.
- PORTFOLIO 4, PALO ALTO ROC OPTION 3: Discharge at a deep-water outfall north of Dumbarton Bridge. This option involves constructing a ROC pump station and holding tank and 13.3 feet of 14-inch HDPE pipe from the AWPF to an existing deep-water outfall in Redwood City. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.

The Draft Countywide Master Plan uses ROC management option 1 at the Palo Alto AWPF as a placeholder for estimating costs.

Portfolio 4 would produce up to 1.8 mgd of ROC from the Sunnyvale AWPF. Valley Water's ROC Management Project Team identified a single option for managing ROC from the Sunnyvale facility:

- PORTFOLIO 4, SUNNYVALE ROC OPTION: Discharge at a new shallow outfall at Guadalupe Slough. This option involves constructing a ROC pump station and holding tank and 6.2 miles of 12-inch HDPE pipe from the AWPF to a new outfall discharge point at Guadalupe Slough. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.

IMPORTANT NOTE: The ROC management strategies and identified solution for each portfolio/option are outdated. (At the time of developing this Draft Countywide Master Plan, the Project Team relied upon GHD's TM dated March 6, 2020 entitled *Task 5 – Basis of Cost Estimates for ROC.*) Valley Water's ROC Management Team is separately developing ROC management strategies, and findings from their work will be integrated into the Draft Final Countywide Master Plan in fall 2020.

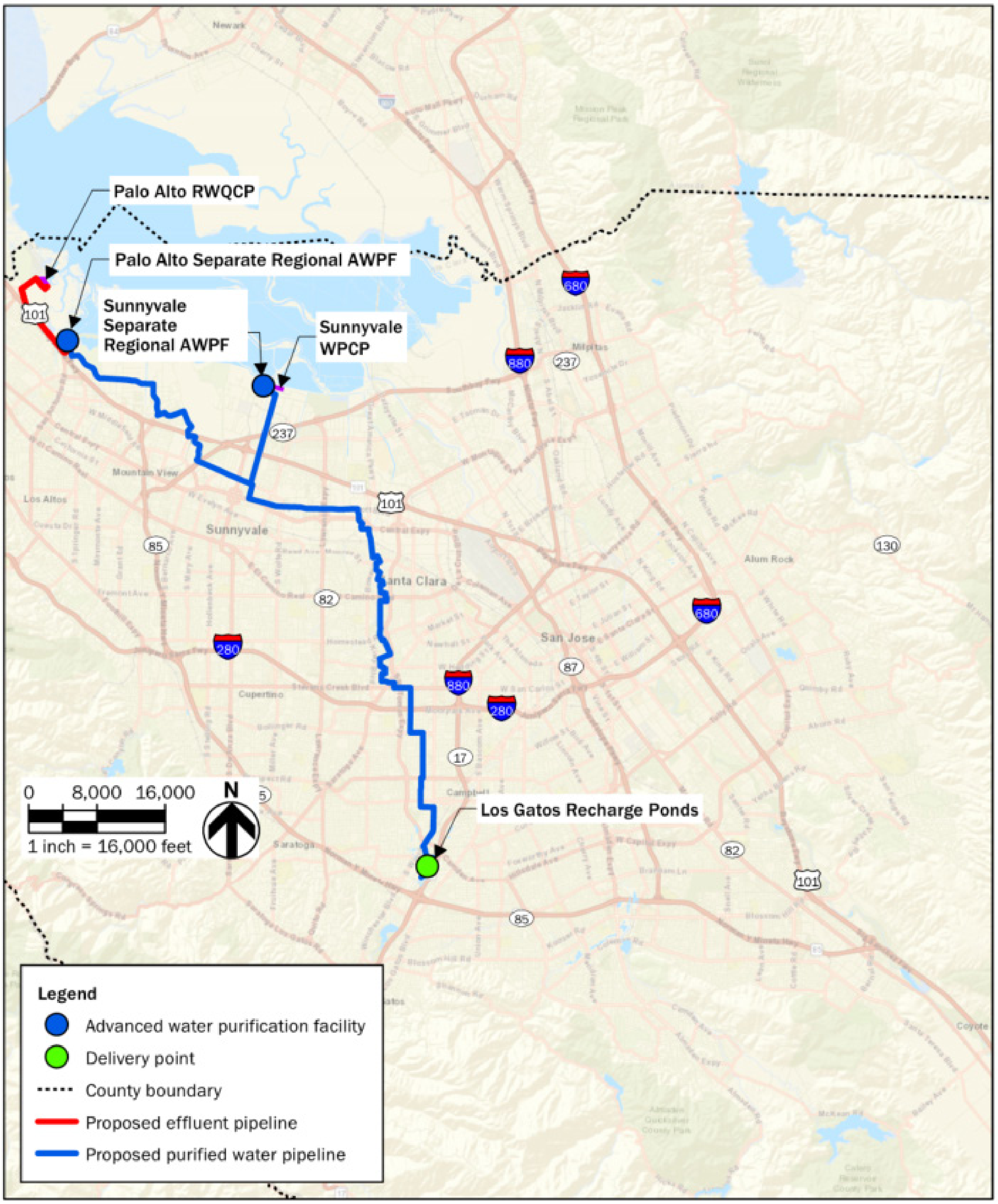


Figure 6-7. Facility locations and pipeline alignments for Portfolio 4 (separate regional Palo Alto and Sunnyvale AWPFs for GWR at LGRP)

6.3 South County Reuse Options

To explore solutions for augmenting water supply in South County, the Project Team reviewed previous reuse studies and plans before developing new conceptual alternatives for consideration. Though the 2015 South County Recycled Water Master Plan (RWMP) (SCRWA, 2016) evaluated reuse alternatives in both Gilroy and Morgan Hill, the recommendations focused on expanding NPR distribution in Gilroy, since the substantial energy and infrastructure required to convey recycled water north from the SCRWA WWTP to Morgan Hill would be less cost-effective. Recycled water service at the SCRWA facility is already challenged in meeting existing maximum day NPR demand in Gilroy (5.2 mgd in 2014), using most of the average dry weather influent flow (6.0 mgd in 2014).

SCRWA, Morgan Hill, Gilroy, Valley Water, and the Project Team met (in person and via phone) to explore South County reuse project concepts and collaboratively developed a list of potential opportunities, as summarized in Table 6-8. From this list, SCRWA, Morgan Hill, and Gilroy staff agreed to focus the Countywide Master Plan efforts for South County on improving overall water supply reliability in Morgan Hill and selected three opportunities, referred to as Morgan Hill Options 1, 2, and 3.

Table 6-8. Potential Future South County Reuse Opportunities

Reuse Type	Source Flow	Delivery Point	Summary	Capital Cost ($2019 in millions)
NPR	SCRWA	New Morgan Hill NPR distribution system	Per the 2015 South County RWMP, extend pipeline parallel to existing joint sewer trunk line to convey recycled water from SCRWA in Gilroy to Morgan Hill	$60 [a]
NPR+	SBWR	New Morgan Hill NPR distribution system	Extend Silver Creek Pipeline from Metcalf Energy Center to customers in Morgan Hill; includes a 6-mile pipeline extension and serving peak demands up to 5 mgd for an estimated annualized NPR demand of 2,900 AFY **Referred to as Morgan Hill OPTION 1**	$74 [b]
GWR	Morgan Hill satellite WWTP and AWPF	San Pedro Ponds (assumed location for design and costs)	Recharge Llagas Subbasin using purified water from a satellite WWTP and AWPF in Morgan Hill (flow diverted from the SCRWA trunk line) **Referred to as Morgan Hill OPTION 2**	$130 [b]
SWA	Morgan Hill satellite WWTP and AWPF	Anderson Reservoir	Augment Anderson Reservoir using purified water from a satellite WWTP and AWPF in Morgan Hill, pumping to the reservoir for blending and dilution, and subsequently treating at Santa Teresa and/or Rinconada WTPs. In exchange, Valley Water would recharge Llagas Subbasin with equal volume of raw water from Santa Clara Conduit **Referred to as Morgan Hill OPTION 3**	$150 [b]
SWA	SCRWA and Gilroy AWPF	Coyote Reservoir	Augment Coyote Reservoir using purified water from an AWPF at SCRWA (Gilroy), pumping to the reservoir for blending and dilution, and subsequently treating at Santa Teresa and/or Rinconada WTPs. In exchange, Valley Water would recharge Llagas Subbasin with equal volume of raw water from Santa Clara Conduit	-- [c]
RWA	SCRWA and Gilroy AWPF	Pacheco Conduit	Pump purified water from an AWPF at SCRWA (Gilroy) to Pacheco Conduit for RWA at Santa Teresa and/or Rinconada WTPs. In exchange, Valley Water would recharge Llagas Subbasin with equal volume of raw water from Santa Clara Conduit	-- [c]
TWA	Morgan Hill satellite WWTP and AWPF	Morgan Hill potable distribution system	Deliver purified water from a satellite WWTP and AWPF in Morgan Hill to engineered storage, then into Morgan Hill's potable water distribution system	-- [c]
TWA	SCRWA and Gilroy AWPF	Gilroy potable distribution system	Deliver purified water from an AWPF at SCRWA to engineered storage, then into Gilroy's potable water distribution system	-- [c]

a. Costs from SCRWA (2016) escalated to 2019 dollars.
b. See Appendix A-6: Cost Estimates for cost details.
c. Not available

Morgan Hill reuse options were developed to the same level of detail as North County portfolios, including preliminary designs and AACE Class 5 cost estimates, as summarized in Table 6-9. Valley Water's ROC Management Project Team reported that the only option available for managing ROC from a Morgan Hill or Gilroy-based AWPF is construction of lined evaporation ponds of about 80 to 100 acres in size at a location not yet identified but assumed to be near the SCRWA WWTP for the purpose of preliminary design and costs.

Table 6-9. Morgan Hill Reuse Options 1, 2, and 3 Key Features and Costs

Morgan Hill Option 1 Highlights: Extend the Silver Creek Pipeline to connect the SBWR system and serve NPR+ to a new recycled water system in Morgan Hill	**Total Capital Cost:** $70M* **Total Annual O&M Cost:** $2.6M* **Unit Cost, 30-Year Lifecycle:** $2,200/AF* **Unit Cost, 100-Year Lifecycle:** $1,700/AF* **Reuse Type & Delivery Point:** NPR+ to a new recycled water distribution system in Morgan Hill **Projected 2040 Yield:** 2,900 AFY **Conveyance Pipeline:** 6-mile extension, 16-inch diameter, 5 mgd capacity **RWS Distribution Pipeline:** 16.4 miles, 16-inch diameter	**BENEFITS** This option would improve water supply reliability for Morgan Hill by importing NPR+ supply from SBWR to serve non-potable demands in place of groundwater, which is currently Morgan Hill's sole water source. Option 1 could be combined with either Option 2 or 3 or Portfolios 2a, 2b, or 4. **LIMITATIONS** An agreement to establish terms of importing SBWR NPR+ supply to Morgan Hill would be needed, as the existing Silver Creek Agreement between Valley Water and San José expires in 2027. Operational impacts to the SBWR system have not been evaluated, and a new reservoir may be needed to supply reliable summertime flows. Further evaluation needed to confirm feasibility of implementing Option 1 and variations of Portfolio 1, as they rely on the same source.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

Morgan Hill Option 2 Highlights: Satellite WWTP and AWPF in Morgan Hill for GWR	**Total Capital Cost:** $125M* **Total Annual O&M Cost:** $6.9M* **Unit Cost, 30-Year Lifecycle:** $6,300/AF* **Unit Cost, 100-Year Lifecycle:** $5,500/AF* **Reuse Type & Delivery Point:** GWR at San Pedro Ponds (assumed location for purpose of preliminary design) **Projected 2040 Yield:** 1,900 AFY **AWPF Design Capacity:** 2.5 mgd **Conveyance Pipeline:** 2.8 miles, 16-inch diameter	**BENEFITS** This option would improve water supply reliability for Morgan Hill by recharging the Llagas Subbasin—an aquifer with limited supply that is strained by agricultural and municipal uses—with purified water. Option 2 could be combined with either Option 1 or Portfolios 1a, 1b, 1c, 1d, 2a, 2b or 4. **LIMITATIONS** This option carries high unit costs. Lined evaporation ponds would be required for ROC management. Option 2 cannot be implemented with Option 3, as they rely on the same source. Meeting existing demands in the South County RWS system is relies on wastewater flow from Morgan Hill. A Morgan Hill satellite facility would increase solids loads to SCRWA, posing operational issues that may be substantial.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

Morgan Hill Option 3 Highlights:

Satellite WWTP and AWPF in Morgan Hill for SWA

Total Capital Cost: $145M*

Total Annual O&M Cost: $7.4M*

Unit Cost, 30-Year Lifecycle: $7,200/AF*

Unit Cost, 100-Year Lifecycle: $6,100/AF*

Reuse Type & Delivery Point: SWA at Anderson Reservoir

Projected 2040 Yield: 1,900 AFY

AWPF Design Capacity: 2.5 mgd

Conveyance Pipeline: 5.6 miles, 16-inch diameter

BENEFITS

This option would improve water supply reliability for Morgan Hill by recharging the Llagas Subbasin—an aquifer with limited supply that is strained by agricultural and municipal uses—with raw water supplied from Valley Water via the Santa Clara Conduit in exchange for an equivalent amount of purified water delivered to Anderson Reservoir for SWA. Option 3 could be combined with either Option 1 or Portfolios 1a, 1b, 1c, 1d, 2a, 2b or 4.

LIMITATIONS

This option carries high unit costs. Details are not yet identified regarding the conditions and reliability of increasing Valley Water's delivery of raw water to Llagas Subbasin in exchange for purified water deliveries to Anderson Reservoir for SWA. Lined evaporation ponds would be required for ROC management. Option 3 cannot be implemented with Option 2, as they rely on the same source. Meeting existing demands in the South County RWS system is relies on wastewater flow from Morgan Hill. A Morgan Hill satellite facility would increase solids loads to SCRWA, posing operational issues that may be substantial.

**Capital cost is rounded to the nearest $5M, O&M cost is rounded to the nearest $100k, and lifecycle unit cost is rounded to the nearest $100. All costs include estimates for ROC management based preliminary findings from Valley Water's ROC Management Team.*

The Morgan Hill satellite AWPF is estimated to produce up to 0.4 mgd of ROC. Valley Water's ROC Management Team identified one option for managing ROC from this facility:

- **MORGAN HILL AWPF, ROC OPTION:** Discharge to a lined evaporation pond of about 80 to 100 acres. Due to the area of land required for this approach and lack of adequately-sized plots in Morgan Hill, Valley Water's ROC Management Team assumed this approach would require pumping ROC and conveying through 11.1-miles of HDPE pipeline of 8-inch diameter to a SCRWA-owned plot of land near the WWTP in Gilroy.

The Draft Countywide Master Plan uses this ROC management approach for the preliminary design and costs related to the Morgan Hill satellite AWPF. However, the viability of the assumed location for the evaporation pond remains in question.

IMPORTANT NOTE: The ROC management strategies and identified solution for each portfolio/option are outdated. (At the time of developing this Draft Countywide Master Plan, the Project Team relied upon GHD's TM dated March 6, 2020 entitled *Task 5 – Basis of Cost Estimates for ROC*.) Valley Water's ROC Management Team is separately developing ROC management strategies, and findings from their work will be integrated into the Draft Final Countywide Master Plan in fall 2020.

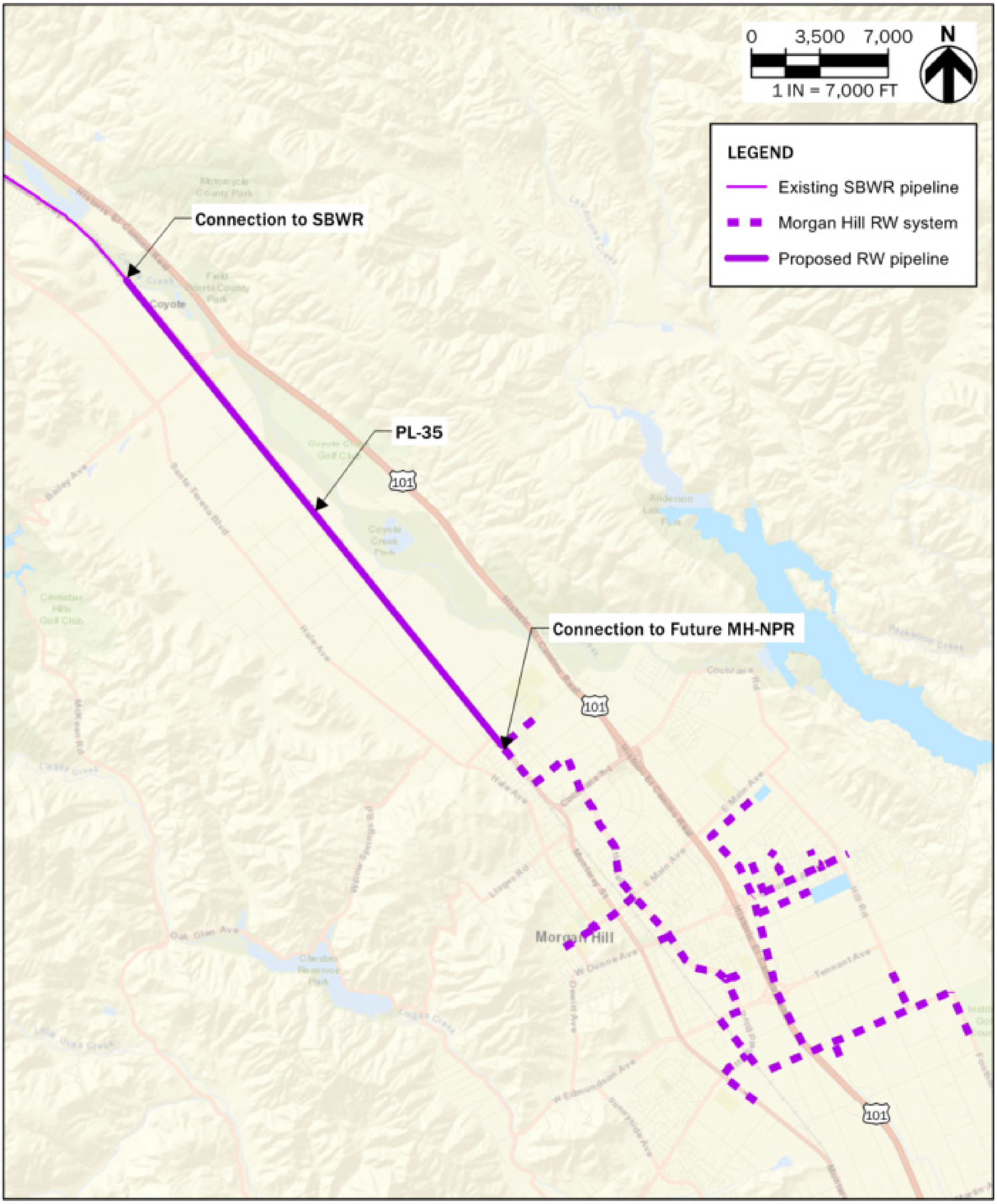


Figure 6-8. Facility locations and pipeline alignments for Morgan Hill Option 1 (NPR+ from SBWR)

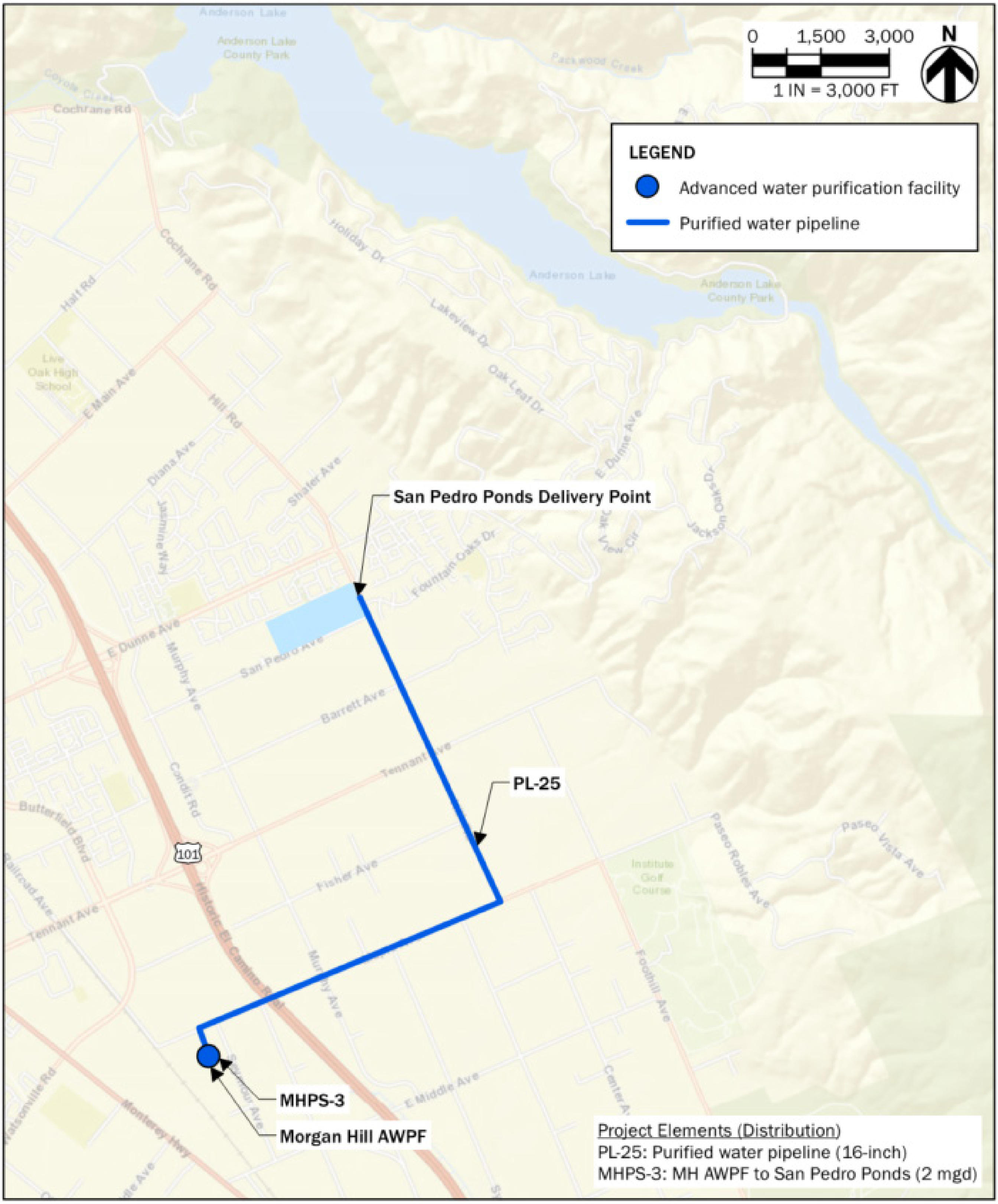


Figure 6-9. Facility locations and pipeline alignments for Morgan Hill Option 2 (Morgan Hill satellite AWPF, GWR at San Pedro Ponds)

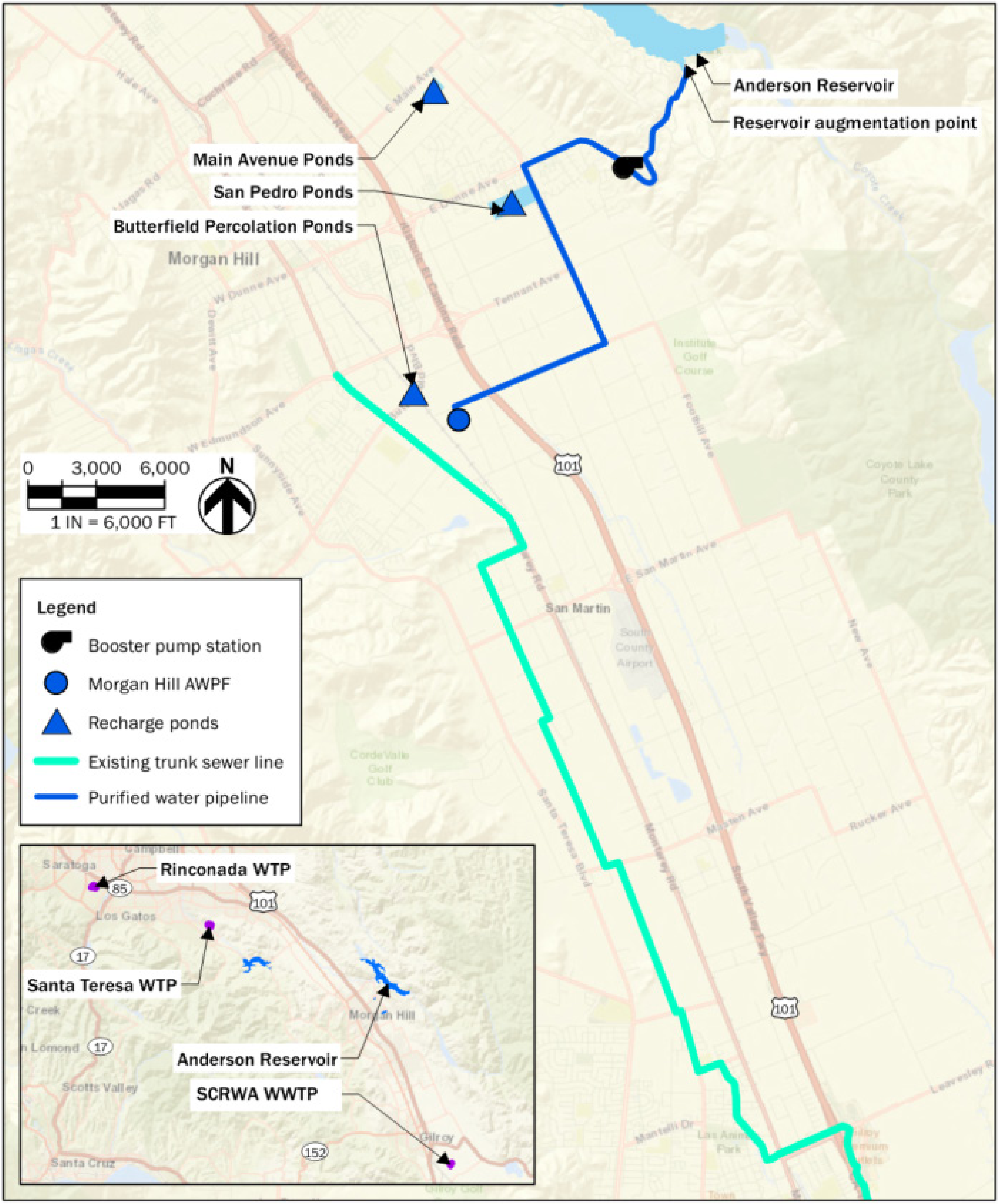


Figure 6-10. Facility locations and pipeline alignments for Morgan Hill Option 3 (Morgan Hill satellite AWPF, SWA at Anderson Reservoir)

6.4 Evaluation and Risk

The Project Team created two tools to compare portfolios: an evaluation tool and a risk tool. The evaluation tool is used to compare portfolios relative to one another with respect to prioritization criteria identified by Valley Water and its Partner Agencies. Risks for each portfolio are assessed separately from the overall evaluation to provide a focused review of aspects that may disrupt, delay, or halt projects. The risk tool assesses the likelihood and consequence of each risk and compiles them into a composite risk score for each portfolio. ***Appendix A-7*** (Evaluation and Risk Tool) provides detailed descriptions of the approaches for developing the tools and how the project team uses them to compare portfolios.

6.4.1 Evaluation Tool

In an October 2018 meeting, Valley Water and its Partner Agencies reached collective agreement on five evaluation criteria representing program goals. Each criterion contains one or more sub-criteria, for a total of 19 sub-criteria that further define each and serve to differentiate between portfolios. Several program goals that are important to Valley Water and its Partner Agencies are not reflected in the latest version of the criteria and sub-criteria because the evaluation tool focuses on sub-criteria that distinguish between portfolios and set them apart from one another. All portfolios protect groundwater and surface water quality, as required by Valley Water.

Criteria and sub-criteria are presented in Table 6-10. As conditions change and new information becomes available, it is anticipated that portfolios will perform differently with respect to the criteria and sub-criteria, and results of the tool will change.

Table 6-10. Criteria and Sub-criteria Built into the Countywide Reuse Evaluation Tool

Criteria	Sub-Criteria (used to further define and score criteria)
Economics	Estimated life-cycle costs: 30-year
Countywide (regional) supply reliability	Projected 2040 PR annual purified water production Purified water delivery point utilization Local reuse benefit – retains reuse supply in same sewer service area
Environmental impacts/benefits and sustainability	Minimizing carbon footprint (evaluated using energy use as a surrogate for carbon emissions) Environmental and social justice Equity in supply benefits (with respect to water rights)
Ease of implementation and regulatory compliance	Partnerships/collaboration Public health regulatory considerations Environmental compliance regulatory considerations Design readiness Anticipated permit requirements Public acceptance/support
Engineering feasibility	Need for pilot study (treatment technology proven at full scale) Pipeline construction Land acquisition / ownership Site preparation requirements Ease of operation

The evaluation tool used a variety of weighting scenarios to change the relative importance of criteria and sub-criteria in scoring the North County portfolios and South County options. ***Appendix A-7*** includes scenario outcomes. For all four weighting scenarios explored by the Project Team, Portfolio 1a outperforms other North County portfolios, and Morgan Hill Option 1 outperforms other South County options.

6.4.2 Risk Tool

The Project Team identified risks within seven categories through input from water reuse subject matter experts, water industry guidance (such as Water Research Foundation's Reference Manual 4715; Water Research Foundation, 2019), and risks discussed during meetings between Valley Water and Partner Agencies. The Project Team qualitatively analyzed risks related to each portfolio/option considering the likelihood and consequence(s) of a particular risk occurring and mitigation strategies that could eliminate the risk or reduce its impact.

Example results from the risk assessment tool for North County portfolios and South County options are presented in Figure 6-11 and ***Appendix A-7.*** Within this example, Portfolios 1a and 2a and Morgan Hill Option 1 offer the lowest composite risk "score" accounting for the multiple risk categories defined within the risk tool.

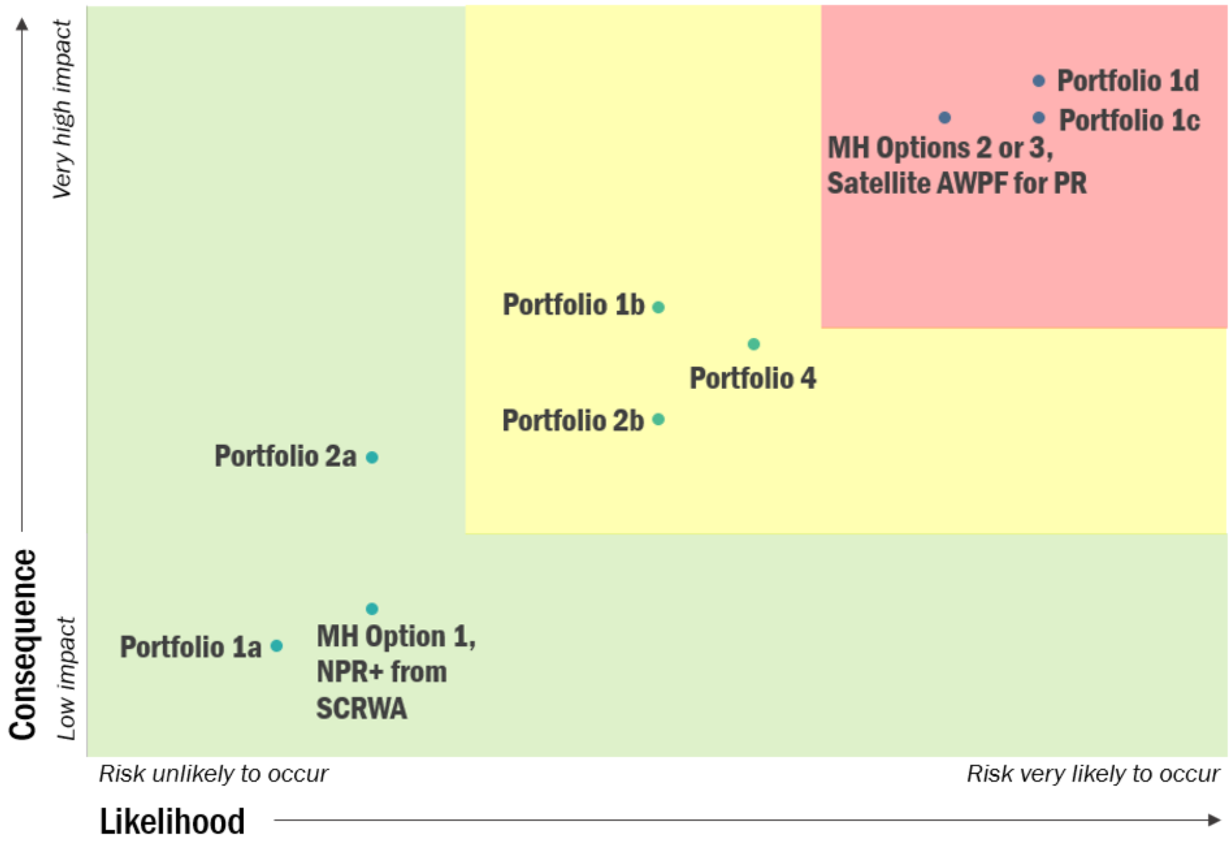


Figure 6-11. Example results of risk assessment tool results to compare Countywide Reuse portfolios and options

Table 6-11. Summary of North County Project Portfolios and South County Reuse Options

Portfolio 1 **San José AWPF**	**Variation**		**Portfolio 1a** Delivers **19,000**-24,000 **AFY** to LGRP for GWR	**Portfolio 1b** Delivers **19,800**-24,000 **AFY** to the SBA terminal tank upstream of Penitencia WTP for RWA	**Portfolio 1c** Delivers **24,000 AFY** total for TWA, including up to 4 mgd directly to Santa Clara and San José (north of Highway 101) and up to 20 mgd to Valley Water's retailers through Milpitas Pipeline (flowing south) to a blending location near Penitencia WTP	**Portfolio 1d** Delivers **24,000 AFY** total for TWA, including up to 4 mgd directly to Santa Clara and San José (north of Highway 101) and up to 20 mgd to Valley Water's retailers through a dedicated purified water pipeline to a blending location near Penitencia WTP
	ROC Management Strategy		Discharge ROC to a new outfall near existing outfall under a separate NPDES permit	Discharge ROC to a new outfall near existing outfall under a separate NPDES permit	Discharge ROC to a new outfall near existing outfall under a separate NPDES permit	Discharge ROC to a new outfall near existing outfall under a separate NPDES permit
	Estimated Costs	**Total Capital Cost**	$630M (+$20M assumed for ROC)	$615M (+$20M assumed for ROC)	$535M (+$20M assumed for ROC)	$585M (+$20M assumed for ROC)
		Annual O&M Cost	$18.4M (+$1.8M assumed for ROC)	$18.9M (+$1.8M assumed for ROC)	$21.4M (+$1.8M assumed for ROC)	$21.5M (+$1.8M assumed for ROC)
		Unit Cost, 30-year Life-cycle	$2,500-**$3,100/AF**	$2,600-**$3,000/AF**	**$2,500/AF**	**$2,600/AF**
		Unit Cost, 100-year Life-cycle	$2,000 -**$2,500/AF**	$2,100-**$2,500/AF**	**$2,100/AF**	**$2,200/AF**
Portfolio 2 **Combined Palo Alto and Sunnyvale Regional AWPF**	**Variation**		**Portfolio 2a** Combines source flow at a regional AWPF in Palo Alto and delivers **17,000**-23,000 **AFY** to LGRP for GWR	**Portfolio 2b** Combines source flow at a regional AWPF in Sunnyvale and delivers **17,000**-23,000 **AFY** to LGRP for GWR		
	ROC Management Strategy		Blend ROC with residual final effluent; discharge at existing outfall	Discharge ROC at a new shallow-water outfall at Guadalupe Slough for enhanced mixing.		
	Estimated Costs	**Total Capital Cost**	$735M (+$40M assumed for ROC)	$755M (+$40M assumed for ROC)		
		Annual O&M Cost	$19.4M (+$1.6M assumed for ROC)	$18.6M (+$1.6M assumed for ROC)		
		Unit Cost, 30-year Life-cycle	$2,900-**$3,800/AF**	$2,900-**$3,800/AF**		
		Unit Cost, 100-year Life-cycle	$2,300-**$3,000/AF**	$2,300-**$3,000/AF**		
Portfolio 4 **Separate Palo Alto and Sunnyvale Regional AWPFs**			**Portfolio 4** Treats source flow at two separate AWPFs and delivers a combined **17,000**-23,000 **AFY** to LGRP for GWR			
	Separate Facility		Palo Alto AWPF	Sunnyvale AWPF		
	ROC Management Strategy		Blend ROC with residual final effluent; discharge at existing outfall	Discharge ROC at a new shallow water outfall at Guadalupe Slough for enhanced mixing		
	Estimated Costs	**Total Capital Cost**	$775M (+$40M assumed for ROC)			
		Annual O&M Cost	$20.2M (+$1.87M assumed for ROC)			
		Unit Cost, 30-year Life-cycle	$3,000-**$4,000/AF**			
		Unit Cost, 100-year Life-cycle	$2,400-**$3,200/AF**			
Morgan Hill Reuse Options	**Variation**		**Option 1** Delivers **2,900 AFY** of NPR+ from SBWR to a new Morgan Hill recycled water system	**Option 2** Delivers **1,900 AFY** from a Morgan Hill satellite WWTP and AWPF to San Pedro Ponds for GWR	**Option 3** Delivers **1,900 AFY** from a Morgan Hill satellite WWTP and AWPF to Anderson Reservoir for SWA	
	ROC Management Strategy		Not applicable	Lined evaporation ponds	Lined evaporation ponds	
	Estimated Costs	**Total Capital Cost**	$70M	$75M (+$50M assumed for ROC)	$95M (+$50M assumed for ROC)	
		Annual O&M Cost	$2.6M	$6.8M (+$0.1M assumed for ROC)	$7.3M (+$0.1M assumed for ROC)	
		Unit Cost, 30-year Life-cycle	**$2,200/AF**	**$6,300/AF**	**$7,200/AF**	
		Unit Cost, 100-year Life-cycle	**$1,700/AF**	**$5,500/AF**	**$6,100/AF**	

Section 7:

Potential Future Opportunities and Alternative Elements

The Countywide Master Plan considers a wide range of reuse scenarios, giving way to a spectrum of applicable regulatory and permitting requirements. In general, regulations for water reuse fall into two categories: public health protection and environmental discharge protection.

7.1.1 NPR/NPR+ Expansion (Featured in All Portfolios)

Partner Agencies each plan to expand their recycled water systems. Figure 7-1 shows the locations of NPR and NPR+ expansion projects as identified in existing recycled water master plans. Section 2.3.1 of ***Appendix A-1*** presents a summary of the capital costs and potential demand for NPR and NPR+ projects that have been previously studied by retailers in their respective recycled water master plans. Projects in the figure do not necessarily reflect full potential buildout conditions for each Partner Agency. If demands for new potential NPR/NPR+ projects as listed in existing recycled water master plans were summed with existing NPR demands throughout the County, the resulting demand projections exceed those identified summarized in 2015 UWMPs. The feasibility and cost-effectiveness of projects are not necessarily confirmed. Further, some projects included in recycled water master plans do not account for full costs, such as retrofits and treatment to improve NPR quality. These factors may contribute to the discrepancy.

Use of recycled water can be a logical, cost-effective water management strategy, depending on site-specific, case-specific circumstances. Many variables play a role in that determination, including the need for supplemental water supply of a certain quality and during specific conditions.

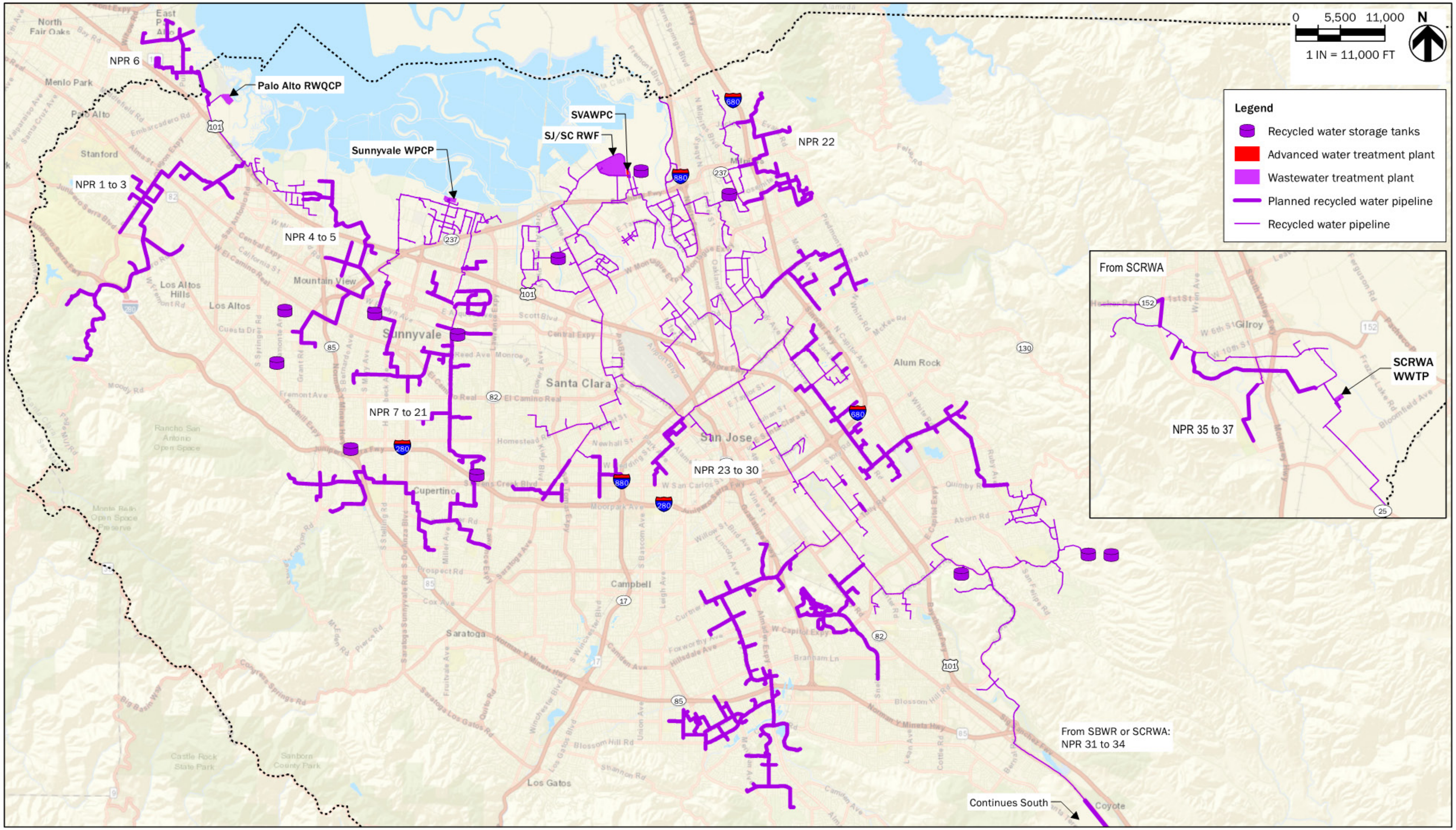


Figure 7-1. Planned expansion of existing recycled water distribution systems throughout Santa Clara County

Note: Recycled water infrastructure improvements are currently undefined for City of Santa Clara and San José Municipal Water service areas.

7.1.2 Interties between Recycled Water Systems

Connecting recycled water systems serves several potential functions, including:

Reliability	If an outage occurs in one system, available capacity from an adjoining system could be used. Supply from an adjoining system could also support pipeline maintenance activities, such as shutdowns of transmission mains.
Peak demand supply mitigation	Peak day and peak hour demands are a challenge in some systems, and supply from an adjoining system could be leveraged to meet demands.
Freeing up effluent for PR	By meeting NPR demands of adjacent systems, the amount of supply offset could provide more flow for PR or ROC dilution. For example, if Sunnyvale's NPR demand was met by SBWR, Sunnyvale could provide more supply for PR or ROC dilution. Vice versa, if SBWR's NPR+ expansion was met using effluent from Sunnyvale, SBWR would be able to confidently meet NPR+ demands even during dry years, allowing for supply for PR.

Interties may require pump stations, pressure-reducing valves, or other facilities depending on the function and operation. Additionally, interties between recycled water distribution systems would need to be accompanied by treatment improvements (i.e., an AWPF for NPR+) to avoid negatively impacting the water quality of a neighboring system. Valley Water has studied pipeline alignments for four intertie opportunities in North County (Figure 7-2):

- **Sunnyvale-SBWR interties.** Three variations of an intertie between Sunnyvale and SBWR were considered, including an effluent intertie to convey secondary effluent from Sunnyvale WPCP to the SJ/SC RWF or SVAWPC and two recycled water interties (one northern and one southern connector).
- **Sunnyvale-PA/MV intertie.** An intertie could connect an existing 16-inch pipeline on Enterprise Way in Sunnyvale to a new 16-inch recycled water pipeline located in Moffett Field.

A more detailed discussion of the length, capital cost, and design assumptions for these interties is included in Section 2.3.2 of ***Appendix A-1.***

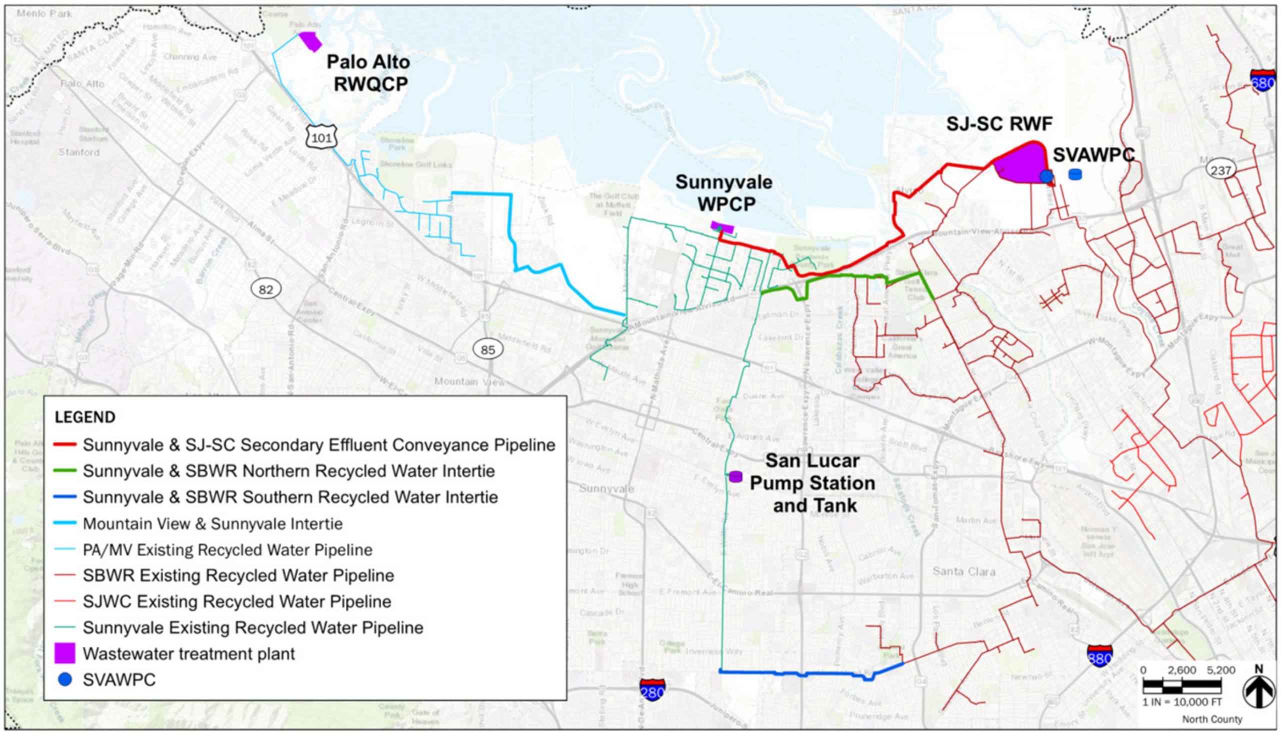

Palo Alto RWQCP
SJ-SC RWF
SVAWPC
Sunnyvale WPCP
San Lucar Pump Station and Tank
LEGEND
Sunnyvale & SJ-SC Secondary Effluent Conveyance Pipeline
Sunnyvale & SBWR Northern Recycled Water Intertie
Sunnyvale & SBWR Southern Recycled Water Intertie
Mountain View & Sunnyvale Intertie
PA/MV Existing Recycled Water Pipeline
SBWR Existing Recycled Water Pipeline
SJWC Existing Recycled Water Pipeline
Sunnyvale Existing Recycled Water Pipeline
Wastewater treatment plant
SVAWPC
0 2,600 5,200
1 IN = 10,000 FT
North County
N

Figure 7-2. Potential interties between Recycled Water Systems

7.1.3 Potential Future Reuse Opportunities and Alternative Elements

Valley Water and its Partner Agencies may consider adapting the portfolios and options summarized in Section 6 to further increase benefits, such as operational flexibility. Such potential future reuse opportunities are summarized below, along with alternatives project elements that are not incorporated into baseline components of any portfolio but may be considered through either a substitution (e.g., an alternate pipeline alignment) or “add-on” (e.g., new interties between NPR+ systems).

Resized design capacity of AWPFs

Several conditions may warrant revisiting and revising the design capacity of AWPFs considered to date to “right-size” projects. For example, Valley Water may consider the impacts of source water availability—that is, long-term agreements with Partner Agencies guaranteeing a minimum flow to support potable reuse—along with any potential refinements to supply planning that changes Board’s Drought Response Target for potable reuse (currently 24,000 AFY) or effluent flow needed for ROC management strategies that involve blended discharge. A limitation to this approach is that phased, incremental increase of an AWPF capacity through strategies like modular construction may be limited by conveyance capacity.

Optimized/resized design of conveyance capacity

The Project Team developed preliminary design of conveyance infrastructure using pipeline diameters consistent with those considered under the Final Expedited Purified Water Program Plan (Valley Water, 2018). However, Valley Water purposefully sized the 48-inch diameter pipelines in the Expedited Purified Water Program Plan to be larger than needed, such that the system would allow for increased flow in the event that Valley Water secured additional source water. Based on a high-level estimate, reducing the Portfolio 1a 48-inch pipeline of about 18.1 miles from San José to LGRP to 42-inch or 36-inch diameter would reduce capital costs by an amount on the order of $45M (15%) and $90M (30%), respectively. Design refinement would be needed to confirm the costs savings, as O&M implications have not been assessed.

Pipeline extension from LGRP to Rinconada WTP

To increase operational flexibility of portfolios involving GWR at LGRP, a pipeline extention and pump station would allow the opportunity to send purified water to Rinconada WTP for RWA. This RWA variation would improve potable reuse supply yield at times when the groundwater basin is filled to capacity and recharge is not possible. Before this pipeline scenario is implemented, AWPFs configured for GWR would require treatment upgrades to align with anticipated regulatory requirements for RWA.

Operational flexibility for DPR portfolios (San José AWPF to Penitencia WTP) via Central Pipeline

Portfolios 1b, 1c, and 1d center around DPR from a San José AWPF, and each features a delivery point proximate to Penitencia WTP, thus allowing an access point to Central Pipeline—an existing raw water conveyance system leading to LGRP and Rinconada WTP—and providing increased operational flexibility. This scenario could allow Valley Water to send purified water from an San José AWPF and route around Penitencia WTP to flow to LGRP for GWR in the interim timeframe, and once DDW has finalized DPR regulations, RWA via Penitencia or TWA may be possible.

Alternate alignments from Palo Alto to LGRP

Portfolio 2a and Portfolio 4 include conveyance of purified water from an AWPF in Palo Alto south to LGRP. Four possible route variations were considered, though one default alignment was selected for the purpose of determining costs and relative pipe lengths across portfolios. By default, Portfolios 2a and 4 both use an eastern route that bypasses Sunnyvale. Alternate routes, shown as dashed lines on in ***Appendix A-1***, include a western route that bypasses Sunnyvale, and two routes (eastern and western) that pass through Sunnyvale. Routes that bypass Sunnyvale are substantially shorter and therefore save pipeline and pumping costs; whereas routes that pass through Sunnyvale allow PR flow to be diverted to the Sunnyvale WPCP for blending with recycled water to produce NPR+.

Alternate alignment from Sunnyvale to LGRP

By default, Portfolio 2b includes the eastern alignment to convey purified water from a Sunnyvale AWPF to LGRP, though there is also a western alignment option shown as a dashed line on the Portfolio 2b figure in ***Appendix A-1***.

West County TWA

Portfolios 1c and 1d explore using SJ/SC RWF source water for TWA because that allows for a case study that presents the full range of potable reuse options for comparison against one another. However, other TWA opportunities exist throughout the County. One option builds on a concept Valley Water is already considering and involves extending the West Pipeline. The Westside TWA Scenario would deliver up to 24,000 AFY of purified water. Like Portfolio 2a, effluent would be conveyed from the Palo Alto RWQCP and Sunnyvale WPCP to a 24-mgd AWPF that would be constructed at the former Los Altos Treatment Plant site. More details about this scenario are included in ***Appendix A-1*** and ***Appendix A-8***.

South County TWA

Two potential South County TWA options have been discussed with staff from Morgan Hill and Gilroy. The first TWA option would use water treated at a satellite WWTP and AWPF in Morgan Hill and then delivered to the Morgan Hill drinking water distribution system. It is likely this option would have a high life-cycle unit cost given the high level of treatment, lack of ROC management options, and limited yield. A second TWA option would use water treated at a new AWPF adjacent to SCRWA in Gilroy and deliver purified water to the Gilroy drinking water distribution system. This option would likely have similar limitations as the first South County TWA option and limit supply available for NPR use in Gilroy.

AWPF for NPR+ in Sunnyvale

Sunnyvale does not have a need for NPR+ in its service area but would need to provide water quality consistent with SBWR or PA/MV NPR+ if interconnecting recycled water systems. Portfolios 2b and 4 have an AWPF located in Sunnyvale and include an additional 0.5 mgd of design capacity to blend PR with NPR supply for NPR+ in Sunnyvale. Portfolio 2a includes a 2,000-foot, 12-inch pipeline that carries 0.5 mgd of purified water from the 48-inch Palo Alto AWPF to the LGRP pipeline south to the Sunnyvale’s San Lucar NPR storage tank. Purified water added to San Lucar would produce NPR+ for distribution throughout Sunnyvale’s RWS.

Additional AWPF in San José for NPR+

Referred to as an “SVAWPC expansion” in some past studies, an additional AWPF may be considered in San José to increase purified water production to meet increasing demands for NPR+ while maintaining a TDS level of 500 mg/L year-round.

Section 8:

Project Implementation Strategy

8.1 Regulatory Compliance Strategy

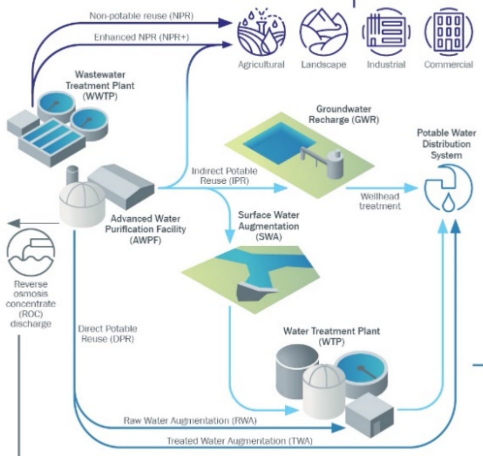
8.1.1 Overview

Assessing the reuse portfolios in terms of regulatory compliance provides a view into issues that might impact their feasibility or future permitting.

The regulatory analysis intends to:

1. **Highlight key regulatory considerations applicable to each portfolio that may impact public health or environmental compliance**
2. **Identify differences between portfolios in terms of potential regulatory and permitting challenges**
3. **Note efforts that are required or may assist with future regulatory and permitting efforts**

The Countywide Master Plan contains potable reuse portfolios in North County that consider GWR, RWA, and TWA and reuse options in South County that consider NPR+, GWR, and SWA. Figure 8-1 summarizes the regulations and required permits for each type of potable reuse.


Non-potable reuse (NPR)
Enhanced NPR (NPR+)
Agricultural
Landscape
Industrial
Commercial
Wastewater Treatment Plant (WWTP)
Groundwater Recharge (GWR)
Potable Water Distribution System
Indirect Potable Reuse (IPR)
Wellhead treatment
Advanced Water Purification Facility (AWPF)
Surface Water Augmentation (SWA)
Reverse osmosis concentrate (ROC) discharge
Direct Potable Reuse (DPR)
Water Treatment Plant (WTP)
Raw Water Augmentation (RWA)
Treated Water Augmentation (TWA)

Non-potable Reuse

CCR, Title 22, Chapter 3

General Order WQ 2016-0068-DDW

SF Bay Basin Plan

SNMP

WDR and/or WRR

Groundwater Recharge

CCR, Title 22, Chapter 3

SF Bay Basin Plan

California Toxics Rule (organism only criteria)

SNMP

Antidegradation Policy

Chlorine residual requirements

WDR, WRR, and potentially NPDES Permit

ROC Management

SF Bay Basin Plan

California Toxics Rule

NPDES Permit

Direct Potable Reuse

California regulations in development for raw and treated water augmentation

Not applicable, no contact with environment

Permit requirements currently uncertain; pending California regulations

Surface Water Augmentation

CCR, Title 22, Chapter 3 and 17

SF Bay Basin Plan

California Toxics Rule (human health and organism criteria)

Antidegradation Policy

Chlorine residual requirements

WDR, WRR, and NPDES Permit

Figure 8-1. Summary of relevant regulations and required documentation for non-potable and potable reuse

8.1.2 Regulatory Compliance Evaluation Results

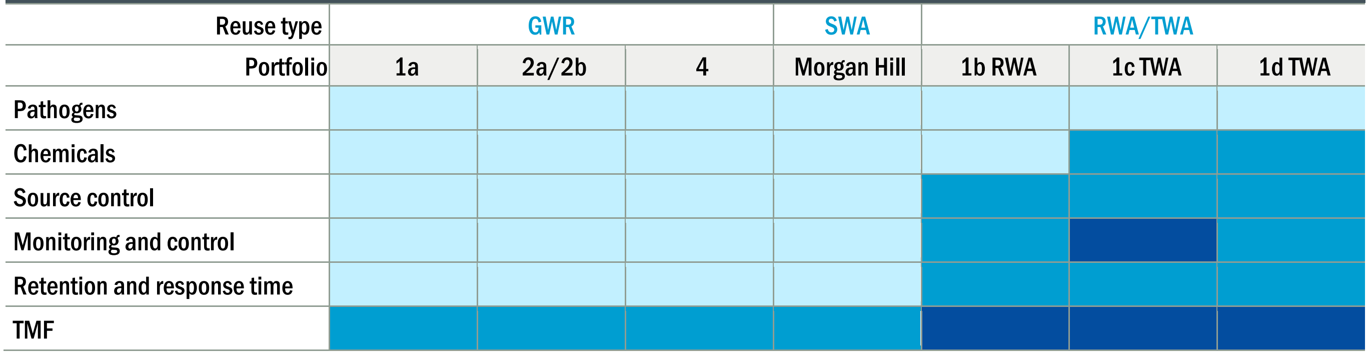
A rubric was developed for each form of reuse to assess the relative difficulty or ease of complying with the associated regulatory criteria and permitting requirements.

Existing regulations for GWR and SWA informed a set of six criteria for evaluating the IPR portfolios.

- Pathogens
- Chemicals
- Source control
- Monitoring and controls
- Retention and response time
- TMF capacity

Ranks were assigned to each criterion based on regulatory certainty, number of precedents, and the experience of other permitted projects. The same six criteria were used to evaluate the RWA and TWA portfolios as well, though assumptions needed to be made in the development of rankings since the State Board has not yet developed DPR regulations. For comparison, Table 8-1 shows the rankings color-coded in light blue (less difficult) to dark blue (more difficult) in terms of regulatory compliance.

Table 8-1. Summary of Regulatory Considerations for Public Health in the Potable Reuse Portfolios



Reuse type	GWR			SWA	RWA/TWA		
Portfolio	1a	2a/2b	4	Morgan Hill	1b RWA	1c TWA	1d TWA
Pathogens	░	░	░	░	░	░	░
Chemicals	░	░	░	░	░	▒	▒
Source control	░	░	░	░	▒	▒	▒
Monitoring and control	░	░	░	░	▒	▓	▒
Retention and response time	░	░	░	░	▒	▒	▒
TMF	▒	▒	▒	▒	▓	▓	▓

The results highlight a spectrum from straightforward compliance with the GWR portfolios to increasingly complex through SWA, RWA, and TWA. Many of the “medium blue” and “dark blue” rankings could improve with greater certainty on specific regulatory criteria as well as potential issues related to multi-agency coordination that influence the evaluation. **Future efforts could help regulators feel more comfortable with these issues. For example, additional demonstration testing might be used to establish the public health protectiveness of a candidate treatment train or to demonstrate the proper functioning of an enhanced monitoring and control system.**

The portfolios must also demonstrate compliance with environmental discharge considerations. Generally, each portfolio must present a plan to address compliance with ROC and—in all but the DPR portfolios—purified water released to the environment. Table 8-2 summarizes regulatory considerations for environmental compliance rankings in the seven portfolios.

Table 8-2. Summary of Regulatory Considerations for Environmental Compliance in the Potable Reuse Portfolios

Reuse type	GWR			SWA	RWA/TWA
Portfolio	1a	2a/2b	4	Morgan Hill	1b/1c/1d
	Environmental Discharge of Purified Water				
SF Basin Plan	░	░	░	░	N/A
California Toxics Rule	░	░	░	█	N/A
SNMP	░	░	░	N/A	N/A
Anti-degradation	░	░	░	░	N/A
Chlorine residual	░	░	░	░	N/A

8.1.3 Regulatory Strategy Next Steps

These rankings are an initial view that can be influenced by several factors, including: (a) engagement and feedback from regulators on the portfolios, (b) greater clarity on the future regulatory requirements for DPR, and (c) additional efforts by Valley Water and its partners to address or resolve the issues marked in "medium blue" and "dark blue."

Strategies to overcome some of these issues and uncertainties include:

- Demonstration testing of the potable reuse treatment systems
- Evaluation of enhanced monitoring and control systems
- Continued partner engagement on interagency agreements
- Pathogen monitoring campaigns to support higher WWTP LRV credits
- Studies to evaluate the amount of blending available in the SWA, RWA, and TWA portfolios
- Evaluation of surface water treatment plant performance and crediting in RWA scenarios
- Communication with the SF Bay Regional Board regarding the feasibility of ROC management strategies
- Communication with the SF Bay Regional Board regarding AWPF product water release to confirm permitting requirements for all portfolios

Additional studies and next steps should be discussed with DDW staff, SF Bay Regional Board staff, and the IAP during their reviews of the North County portfolios. Once greater clarity is obtained on which portfolio(s) will be carried into future phases, additional studies will need to be completed to further support those pursuits. These include reuse-specific studies such as:

- Hydrodynamic studies to confirm mixing and dilution requirements in SWA reservoirs
- Tracer studies to validate hydrodynamic models (SWA)
- Tracer studies to confirm aquifer retention time (GWR)
- Preliminary studies related to ROC discharge and AWPF product water release for all portfolios to confirm feasibility of compliance with applicable environmental requirements

Multiple years may be required to undertake the complete process of implementing a potable reuse project. Various steps are typically involved, starting with the development and testing of a potable reuse concept before moving into the design, permitting, construction, and start-up of the system. Two recently permitted projects—Monterey One Water's GWR project and the City of San Diego's SWA project—were both pursued with expedited timelines and required more than 10 years for completion.

8.2 Rate Impacts

The next iteration of this document (the Draft Final Countywide Water Reuse Master Plan) will include Valley Water's assessment of rate impacts pertaining to the North County portfolios and South County reuse options.

8.3 Public Outreach and Engagement

Public support is integral to the success of any potable reuse program and often represents a greater implementation challenge compared to technical feasibility. Rarely, if ever, does technology stop a potable reuse project from proceeding. In contrast, politics and public perception are common roadblocks. These challenges are not unsurmountable. However, successful public outreach requires careful planning, cohesion among partners, and commitment to consistent and transparent communication. While potable reuse is not yet fully mainstream, it is proven approach and yield reliable, drought-resistant, safe, high-quality drinking water supply. Valley Water and its Project Partners can count on those that have successfully forged a path for getting public support—and even enthusiastic support—by understanding and implementing best practices and remaining mindful of avoiding pitfalls.

Alignment on a public outreach and engagement strategy is needed at many levels across partners, such as Valley Water and its Partner Agencies. An important early step is collaboration among the project partners' respective locally-elected officials and policymakers to confirm support for potable reuse, if not fully exercise their leadership voices as reuse champions, and commit support for executing an action plan for public outreach

To set the direction for future community and ratepayer engagement related to implementing a potable reuse program in Santa Clara County, Valley Water and the Project Team surveyed Partner Agencies through an online poll and compiled their input on preferred public outreach approaches, related opportunities, and key concerns/challenges. Following the online survey in early June 2020, Valley Water and the Project Team hosted a virtual workshop with Partner Agencies and water retailers throughout the county to further explore the approach for future public outreach and engagement related to potable reuse. Through the polling results and real-time input, the Project Team identified some key themes and insights, summarized as follows.

Coordinated, collaborative outreach program led by Valley Water with local support for implementation.

Partner Agencies and water retailers have strong interest in collaborating regionally with Valley Water to advance potable reuse, relying on Valley Water to lead and fund outreach as part of next steps. Most stated a lack of adequate resources to conduct effective outreach and a lack of confidence with their ability to advance a related outreach program on their own.

Articulate messaging is needed to convey strategic, unique value of potable reuse.

As Project Agencies have emphasized, among the earliest steps is a need to articulate the strategic and unique value potable reuse opportunities hold for the County in terms of addressing vulnerability of the existing supply portfolio, buffering risk, and strengthening resilience and dry year supply reliability.

Pilot project, such as public taste tests of purified water, may be helpful.

Uncertainty about whether one project or multiple projects will be advance limits Partner Agencies' ability to identify what may be needed to increase effective outreach or whether a pilot for public taste tasting is desirable.

Issues of greatest concern are similar to other potable reuse programs.

The Partner Agencies and water retailers identified several challenges and issues of greatest concern related to public outreach that closely resemble those from other potable reuse programs: (1) trust in water purification science, (2) quality of the water/what if something goes wrong, (3) project cost/water bill impact, and (4) real time testing and monitoring.

Valley Water's recent public survey will likely shed more light on the local communities' support for reuse, as well as their tolerance to a potential rate increase. The Draft Final Countywide Master Plan will be updated to reflect this information.

8.4 Partnerships and Governance

As Valley Water and its Partner Agencies advance the Countywide Reuse Program toward implementation, the need for establishing institutional arrangements and agreement on governance structures will become imperative. While the scope of this Countywide Master Plan does not address institutional partnership arrangements or governance, substantial coordination and thought leadership among the project partners has occurred around these topics over many years.

For example, in November 2008, members of Valley Water's Board, San José's City Council, and Santa Clara's Mayor held a Recycled Water Liaison Committee meeting to develop long-term agreement program element options. The group discussed four collaborative agreement models that represent how Valley Water could work together with SBWR to enable increased water reuse in the County. These models could still be used to shape new Partner Agency agreements today:

1. **Funding/Incentive Agreement:** Valley Water would provide an incentive to the Partner Agency in $/AF for administering the WWTP and RWS. The parties would need to agree on cost-sharing and responsibilities for individual joint facilities on an individual basis.
2. **Customer Contract for Purchase:** Valley Water would sign a contract with a Partner Agency for the purchase of recycled water in future years. The Partner Agency would retain its role and relationship with existing customers and receive revenue from additional recycled water sales, while Valley Water could ask for a guaranteed supply of recycled water. This agreement structure is similar to the relationship between West Bay Municipal Water District and Los Angeles County Sanitation District.
3. **Cooperative Agreement:** The Partner Agency and Valley Water would form a committee of the two agencies and share capital costs for new facilities as well as early operations and maintenance costs.
4. **Joint Powers Authority (JPA):** Could be set up to manage reuse within the County, handle regional water exchanges, and act on behalf of Valley Water and Partner Agencies.

The models and potentially new concepts will be explored as part of implementation.

8.5 Policy Issues

Throughout development of the Countywide Master Plan, Partner Agencies have identified policy issues require consideration and/or resolution to promote willingness to execute new long-term agreements. Some examples include the following.

Equity issues related to water assurance disparities

California's system for allocating water supply has long been a source of controversy due to its complexity, ambiguity, and inequities. Some Partner Agencies have security in water assurances for meeting their communities' future needs even during drought, while others are similarly opposite. San José Municipal Water is in the latter category. Thus, creating an imbalance in water security by moving water from a community with less-secure water assurance to a neighboring community (and particularly to one with more secure water rights) is problematic and would require a policy-level intervention to resolve. This issue is included as a sub-criterion in the evaluation tool.

Opportunities for water supply transfers or exchanges

A water transfer or exchange could help address the issue related to equity in water assurance issue, whereby the areas with less-secure water rights is given an option to purchase potable supply from area the more-secure water rights in exchange for NPR supply or reuse source water. In addition, the flexibility of RWA and TWA portfolios could be increased if supported by agreements to transfer or exchange supply among water suppliers to balance needs and supplies.

Distributed systems approach with fit-for-community reuse strategies

Interest in onsite (decentralized) NPR systems seems to be growing among private sector companies in Silicon Valley, particularly technology providers. Onsite reuse refers to building- or development-scale wastewater treatment and reuse of the treated stream for non-potable uses at the building or development site (e.g., irrigation, toilet-flushing, cooling tower water). The combination of this growing trend and flatline WWTP influent flows over recent years may result in competing demands for wastewater as a resource. If not properly managed, this approach may cause impacts to centralized treatment and infrastructure resulting in a ripple effect with impacts to cost, energy, and other factors. the distributed systems approach is a regionally optimized blend of both centralized and onsite reuse. These potential impacts may be mitigated by taking a Countywide distributed systems approach to optimize the blend of both centralized reuse projects—like the portfolios considered under this Countywide Master Plan—and onsite reuse to reflect local conditions in a fit-for-community strategy to identify effective ways to control costs, reduce greenhouse gas emissions, increase public awareness, and advance environmental stewardship throughout the communities in the County. Valley Water and its Partner Agencies may consider reevaluating source flow availability annually to monitor impacts and trends related to onsite reuse.

Priorities and reuse understanding among elected officials

Political will and support for reuse shifts with the tides of election cycles. Changes in elected officials brings uncertainty. In advancing next steps, a primer to orient new elected officials with water reuse concepts and the history of reuse and related partnerships within the County may have merit.

8.6 Programmatic Environmental Review

Valley Water will produce a Programmatic Environmental Impact Report/Programmatic Environmental Impact Study (PEIR/PEIS) that addresses NEPA and CEQA requirements and encompasses the full

spectrum of project portfolios/reuse options and alternative alignments. The PEIR/PEIS will support the implementation of the Master Plan's feasible project portfolios in North County, reuse options in South County, and alternative project elements. It will also provide flexibility for Valley Water to move ahead with various combinations of portfolios and elements and to phase construction as needed.

According to Section 15168 of CEQA Guidelines, a PEIR describes impacts resulting from a series of actions that can be characterized as one large program. A PEIR acts as a foundation to support individual project-level environmental documents that will be subsequently prepared based on the selected portfolio(s), option(s), and/or element(s).

The level of effort for NEPA/CEQA is anticipated to be significant. Anticipated permitting requirements for each portfolio are included as a sub-criterion of the evaluation tool (see Section 6.4.1 and ***Appendix A-7***).

8.7 Program Funding

When strategizing and planning funding to support the program's implementation, Valley Water will first need to establish whether to use private or public financing.

Private financing through a public-private partnership (P3) partner assumes payments begin when a facility is operational, less Valley Water's 30 percent share of debt financing. Valley Water is exploring several public financing alternatives, summarized as follows.

- **Low-interest loans,** such as those offered under Water Infrastructure Finance and Innovation Act (WIFIA), Clean Water State Revolving Fund (CWSRF) Loan Program, and/or Infrastructure SRF (ISRF) Loan Program
- **Grant funding,** such as programs established under Title XVI of the Reclamation Projects Authorization and Adjustment Act, Water Recycling Funding Program (WRPF) Construction Grants, and/or Integrated Regional Water Management (IRWM) Grants
- **Potential stimulus funding** based on the precedent set by the American Recovery and Reinvestment Act (ARRA) of 2009

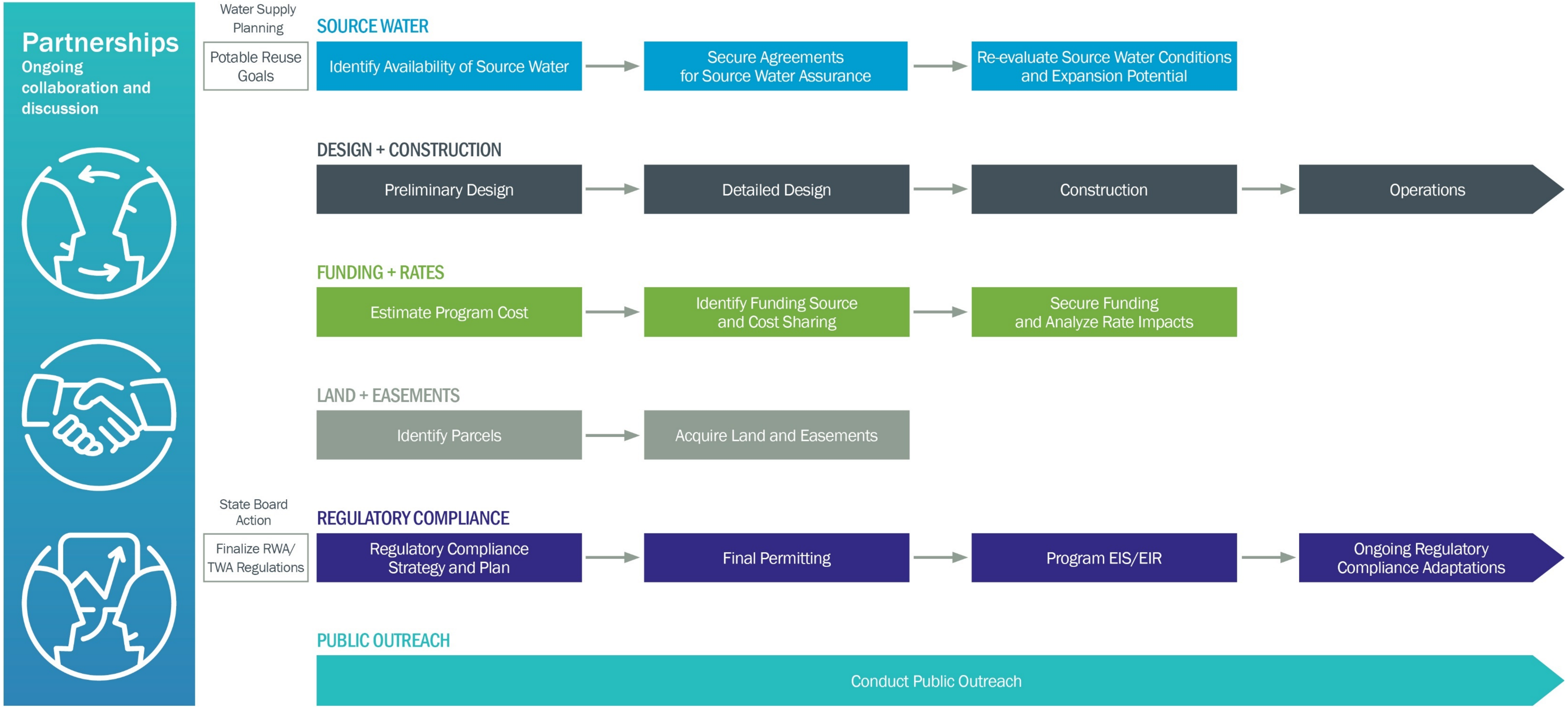
Each of these alternatives has a unique set of eligibility requirements, criteria for scoring, and funding terms. For example, WIFIA favors projects that generate economic benefits and address water resource challenges, specifically pointing to groundwater recharge and water reuse, with assumed repayment of 49 percent of capital costs 5 years after the respective AWPF is operational. However, if Valley Water proceeds with implementation under a P3—either as a fixed-price design-build-finance-operate-maintain (DBFOM) with a sufficiently defined project to anticipate costs or a progressive DBFOM to further develop the project concepts and costs—an SRF loan would be precluded.

The total program cost to be financed depends on construction timing and duration, along with apparent factors such as facility size. As well, public financing opportunities may vary with time, and the future availability of funding programs available currently and over the near-term is uncertain.

8.8 Recommended Next Steps for Implementation

Implementing the Master Plan project(s) will not be a linear process. Valley Water will need to work with Partner Agencies on multiple implementation steps simultaneously, and the interdependency of some of those steps adds complexity. Figure 8-2 depicts a simplistic view of implementation steps within several parallel categories without indicating the complexities added by interrelationships. For example, securing source water through establishing long-term agreements is needed before proceeding with detailed design; yet, program costs and other factors may influence agreement terms.

Next Steps for Implementation



Partnerships

Ongoing collaboration and discussion

Water Supply Planning

Potable Reuse Goals

SOURCE WATER

Identify Availability of Source Water → Secure Agreements for Source Water Assurance → Re-evaluate Source Water Conditions and Expansion Potential

DESIGN + CONSTRUCTION

Preliminary Design → Detailed Design → Construction → Operations

FUNDING + RATES

Estimate Program Cost → Identify Funding Source and Cost Sharing → Secure Funding and Analyze Rate Impacts

LAND + EASEMENTS

Identify Parcels → Acquire Land and Easements

State Board Action

Finalize RWA/ TWA Regulations

REGULATORY COMPLIANCE

Regulatory Compliance Strategy and Plan → Final Permitting → Program EIS/EIR → Ongoing Regulatory Compliance Adaptations

PUBLIC OUTREACH

Conduct Public Outreach

Figure 8-2. Categorized next steps for implementing Countywide reuse

To implement a water reuse program within the County, Valley Water must work closely with its Partner Agencies and Board of Directors, including Recycled Water Committee members, to take the following steps, many of which are interdependent and are not listed sequentially.

✓ Initiate Countywide collaborative potable reuse **public outreach and engagement** informed by portfolios to be implemented, planned project locations, and rate impacts.

✓ Start **programmatic environmental review** at the end of preliminary design and proceed with permitting following release of the final PEIS/PEIR.

✓ Continue to refine **regulatory compliance** strategy as reuse opportunities take shape and new DPR regulations are established. Seek Regional Board buy-in on ROC management.

✓ Refine **reuse goals** based on pending updates to water demand projections. Confirm minimum available **source water** to secure partnership agreement(s) and achieve goals. Resolve **policy issues** and define governance structure.

✓ Execute **long-term agreements** for source water and confirm project portfolios and alternative elements for implementation based on partnership agreements. Prepare **refined designs** to right-size projects based on available flows.

✓ Acquire **land and/or easements** for reuse program/projects and identify roles and responsibilities for site preparation.

✓ Secure **program funding** and analyze resulting **rate impacts**.

Section 9:

Appendices List

Appendices are compiled in a separate file and include the following (ordered by relevance/importance).

Appendix A: Feasible Project Portfolios

Appendix A-1: Feasible Project Portfolios TM

Appendix A-2: Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield

Appendix A-3: Design Criteria

Appendix A-4: Preliminary Project Designs

Appendix A-5: Basis of Cost

Appendix A-6: Cost Estimates

Appendix A-7: Evaluation and Risk Assessment Tool

Appendix A-8: Treated Water Augmentation Pre-Screening Analysis

Appendix B: Regulatory Compliance

Appendix B-1: Regulatory Compliance Strategy TM

Appendix B-2: Regulatory Framework TM

Appendix C: Hydraulic Modeling

Appendix C-1: Modeling Plan and Results

Appendix C-2: SBWR System Master Plan TM

Appendix D: Project Definition, Roles, and Responsibilities

Appendix D-1: Project Definition, Roles, and Responsibilities

Appendix E: Baseline Analysis

Appendix E-1: Baseline Analysis

Appendix E-2: Recycle Hill Geotechnical Preliminary Study

Appendix E-3: Recycle Hill Geotechnical and Geo-environmental Exploration Plan

Appendix F: Conceptual Alternatives

Appendix F-1: Conceptual Alternatives

Appendix G: ROC Management Reference Files

Section 10:

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DRAFT

Countywide Water Reuse Master Plan
Appendices

Prepared for
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June 30, 2020

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Appendix A: Feasible Project Portfolios

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Appendix A-1: Feasible Project Portfolios TM

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Technical Memorandum

DRAFT

Prepared for: Santa Clara Valley Water District (Valley Water)

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Project no.: 4821 (Valley Water); 151772 (BC internal)

Contract no.: A4120A

Appendix A-1

Subject: Feasible Project Portfolios

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Limitations:

This is a draft memorandum and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.

This document was prepared solely for Santa Clara Valley Water District in accordance with professional standards at the time the services were performed and in accordance with the contract between Santa Clara Valley Water District and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Santa Clara Valley Water District; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Santa Clara Valley Water District and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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List of Abbreviations

$/AF	dollar per acre-foot
µm	micrometer
AB	Assembly Bill
ABAG	Association of Bay Area Governments
ADWF	average dry weather flow
AF	acre-foot/feet
AFY	acre-foot/feet per year
AOP	advanced oxidation process
AWPF	advanced water purification facility
BAC	biologically active carbon
BODR	Basis of Design Report
Cal Water	California Water Service Company
CC	Central Coast
CCCI	California Construction Cost Index
CCSCE	Center for the Continuing Study of the California Economy
CEC	constituent of emerging concern
CEQA	California Environmental Quality Act
CIWQS	California Integrated Water Quality System
County	Santa Clara County
D9	Draft Countywide Water Reuse Master Plan
DBP	disinfection byproduct(s)
DDW	Division of Drinking Water
DPR	direct potable reuse
EIR	Environmental Impact Report
FAT	full advanced treatment
FM	force main
FSRWE	Feasibility Study for Recycled Water Expansion
ft	foot/feet
GAC	granular activated carbon
GHG	greenhouse gas
gpm	gallon(s) per minute
GWR	groundwater recharge
HDPE	high-density polyethylene
hp	horsepower
hr	hour(s)
IAP	Independent Advisory Panel
in.	inch(es)
IPR	indirect potable reuse
kWh	kilowatt-hour(s)
L	liter(s)
LATP	Los Altos Treatment Plant
lb	pound(s)
LF	linear foot/feet
LGRP	Los Gatos Recharge Ponds
LRV	log reduction value
M	million(s)
Master Plan	Countywide Water Reuse Master Plan
MBR	membrane bioreactor
MF	microfiltration
MG	million gallons
mg/L	milligram(s) per liter
mgd	million gallons per day
mJ/cm^2	millijoules per square centimeter
MP	midpoint
N/A	not applicable
NASA	National Aeronautics and Space Administration
NDMA	N-nitrosodimethylamine
NEPA	National Environmental Protection Act
nm	nanometer
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NPR+	enhanced non-potable reuse
NPV	net present value
NWRI	National Water Research Institute
O&M	operations and maintenance
O_3	ozone
off-spec	off-specification
PA/MV	Palo Alto/Mountain View
PDT	pressure decay test

PL	pipeline
PPG	Project Partner Group
PR	potable reuse
PS	pump station
R&R	replacement and renewal
Regional Board	Regional Water Quality Control Board
RMA	Resource Management Associations
RO	reverse osmosis
ROC	RO concentrate
ROCMP	ROC Management Plan
RWA	raw water augmentation
RWF	regional wastewater facility
RWMP	Recycled Water Master Plan
RWQCP	Regional Water Quality Control Plant
RWS	recycled water system
SBA	South Bay Aqueduct
SBWR	South Bay Water Recycling
SCRWA	South County Regional Wastewater Authority
SF Bay	San Francisco Bay
SFPUC	San Francisco Public Utilities Commission
SJ/SC	San José-Santa Clara
SJ Muni	San José Municipal Water System
SJW	San Jose Water[1]
SNMP	Salt and Nutrient Management Plan
State Board	State Water Resources Control Board
SVAWPC	Silicon Valley Advanced Water Purification Center
SWA	surface water augmentation
TAF	thousand acre-feet
TBD	To be determined
TDH	total dynamic head
TDS	total dissolved solids
TM	technical memorandum
TOC	total organic carbon
TWA	treated water augmentation
UF	ultrafiltration
UV	ultraviolet
UV/AOP	ultraviolet/advanced oxidation process
UVT	UV transmittance
UWMP	Urban Water Management Plan
V/G/C	virus/*Giardia/Cryptosporidium*
V/Q	volume divided by flow
Valley Water	Santa Clara Valley Water District
WEAP	Water Evaluation and Planning System
WPCP	Water Pollution Control Plant
WQO	water quality objective
WSMP	Water Supply Master Plan
WTP	water treatment plant
WWTP	wastewater treatment plant

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[1] San Jose Water does not use an accent in their name, though City of San José does.

Executive Summary

Santa Clara Valley Water District (Valley Water) initiated development of the Countywide Water Reuse Master Plan (Master Plan) to integrate existing recycled water studies, plans, and infrastructure in partnership with four existing recycled water systems (RWS) delivering non-potable reuse (NPR) water in Santa Clara County (County) (Figure ES-1). Referred to as Partner Agencies, the NPR producers include:

- **San José/Santa Clara Regional Wastewater Facility (SJ/SC RWF):** The SJ/SC RWF produces recycled water for wholesale distribution via the South Bay Water Recycling (SBWR) system.
- **City of Palo Alto:** The Palo Alto Regional Water Quality Control Plant (RWQCP) produces recycled water for distribution in the Palo Alto / Mountain View (PA/MV) RWS.
- **City of Sunnyvale:** The Sunnyvale Water Pollution Control Plant (WPCP) produces recycled water for distribution in the Sunnyvale RWS.
- **South County Regional Wastewater Authority (SCRWA):** SCRWA produces recycled water for distribution in the South County RWS.

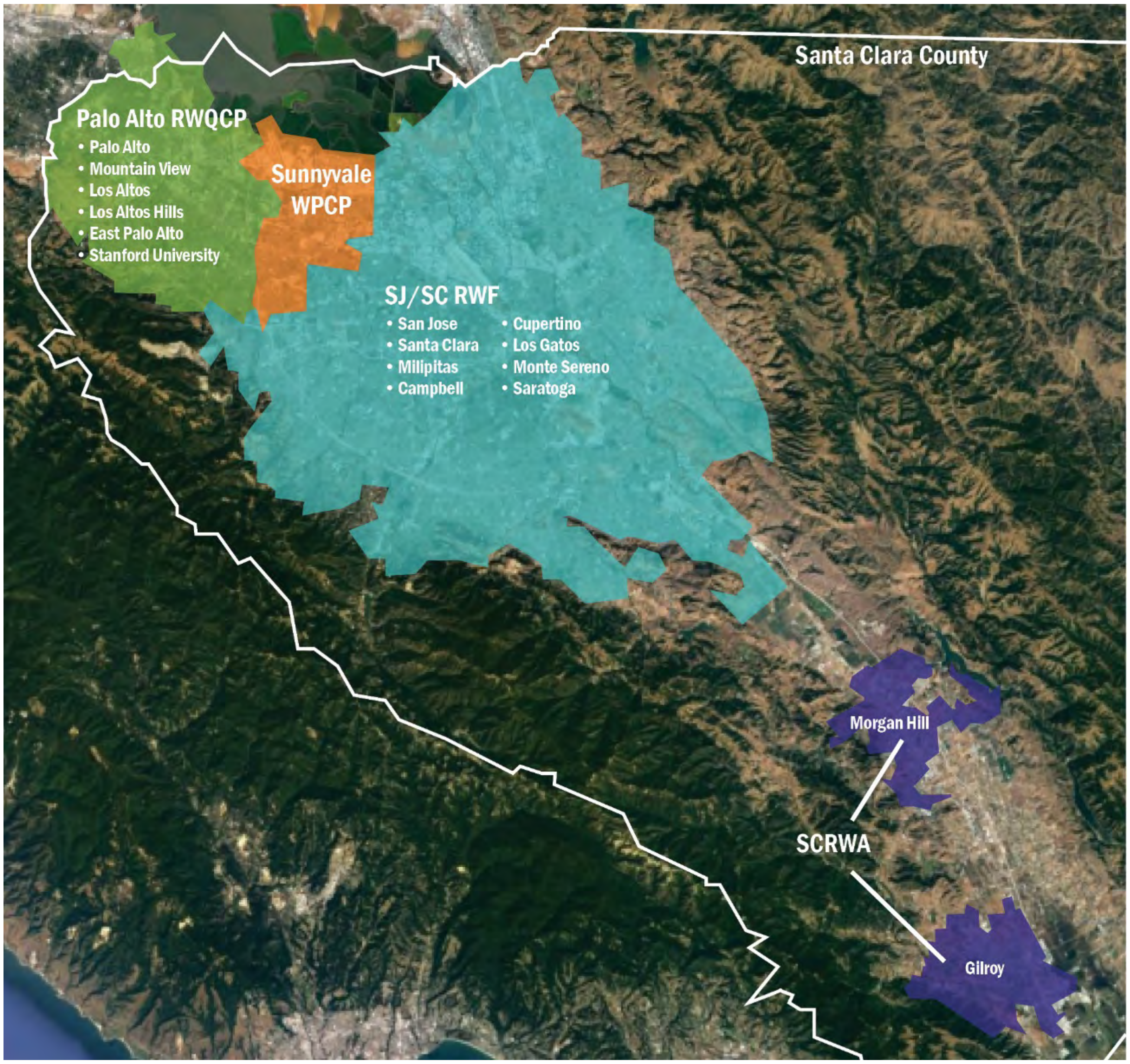

Figure ES-1. Partner Agencies' sewershed areas and cities contributing flows

The Master Plan will provide a framework to make collaborative decisions related to integrated actions to increase the region's water supply reliability through reuse, as applied to a planning horizon through 2040. Objectives of the Master Plan include:

1. **Determine reuse supply availability and benefits.**
2. **Evaluate potential regional integration.**
3. **Guide system expansion through interagency agreements and governance.**
4. **Solicit input and generate regional support for the Master Plan via coordination and stakeholder outreach.**

The Master Plan will present and evaluate several portfolios (formerly called alternatives) of potential future reuse projects, along with related information that may support potential future interagency agreements and governance.

Appendix A-1: Feasible Project Portfolios Technical Memorandum (TM) is an interim deliverable that builds on the Conceptual Alternatives TM (Appendix F), which assessed five portfolios and identified three to carry forward for feasibility analysis. This TM further defines project elements—essentially the building blocks of the three portfolios—to a preliminary (10 percent) design level and evaluates the portfolios against several criteria, such as economics, environmental benefits/impacts, and ease of implementation. This TM serves as a critical foundation for the Master Plan by laying out the benefits, costs, and risks of each portfolio.

Project Elements

The portfolios are each composed of sets of project elements in two general categories: treatment facilities and conveyance/distribution facilities (i.e., pipelines and pump stations).

Treatment Facilities

The treatment facilities are distinguished by source water, treatment level, and delivery point, as summarized below.

Source Water. The proposed advanced water purification facilities (AWPF) treat wastewater from four sources:

- SJ/SC RWF
- Palo Alto RWQCP
- Sunnyvale WPCP
- Morgan Hill trunk sewer (for satellite treatment)

Source water availability depends on several factors, including projected wastewater influent and outflow streams (e.g., NPR demands, environmental flows, and losses). To account for uncertainty in future influent projections, a range of flows was considered. The lower bound assumes influent remains constant through the planning horizon. The upper bound uses the same baseline but assumes flows increase at the rate projected in individual agencies' wastewater or recycled water master plans.

As shown in Table ES-1, San José/Santa Clara RWF is expected to have sufficient source water to meet Valley Water's goal of 24,000 acre-feet per year (AFY) for potable reuse (PR). For an AWPF dependent on effluent from Sunnyvale or Palo Alto, there is a risk of lower yield (below Valley Water's goal). In South County, the satellite option depends on the availability of raw wastewater from Morgan Hill, which fluctuates seasonally. More details on the flow evaluation are included in Appendix A-2: Compendium of flow assessments, facility design capacity, and annual yield calculations.

Table ES-1. Summary of Flow and Yield Evaluation (Projected Annual Flows)

	Annual Average Flows		NPR Flows		PR Flows (at selected capacity)[a]		
Location	Future Influent (mgd)	Losses/ Environmental Flows (mgd)	Future NPR Demands (mgd)	ROC from NPR+ (mgd)	Available Effluent for PR[b] (mgd)	Average Purified Water Production (mgd)	Annual Purified Water Yield (AFY)
SJ/SC	100.5 to 108.2	--	27.6 [c]	1.8 [d]	71 to 78.7	21.6 [e]	24,000 [e]
Palo Alto	19.3 to 21.3	3.3 [f]	2.5	0.2	13.3 to 15.3	10.5 to 11.8 [g]	11,700 to 13,200 [g]
Sunnyvale	11.9 to 16.9	4.0 [h]	1.5	0.1	6.3 to 11.3	4.9 to 8.8 [g]	5,500 to 9,800 [g]
Morgan Hill	--	--	--	--	2.1	1.7	1,900

a. Selected AWPF capacities for PR (does not include additional capacity needed for NPR+): (1) Sunnyvale, 10 mgd, (2) Palo Alto, 14 mgd, (3) SJ/SC, 24 mgd, and (4) Morgan Hill, 2.1 mgd.

b. Some effluent may be required for discharge, blending, or other purposes.

c. Future NPR demand for SBWR retailers, provided by SBWR staff. Does not include potential future NPR demand in Morgan Hill.

d. To improve water quality of NPR to meet a total dissolved solids (TDS) target of 500 milligrams per liter (mg/L) year-round. (Existing Silicon Valley Advanced Water Purification Center [SVAWPC] capacity is 8 mgd).

e. Assuming 90% AWPF online factor (sufficient effluent is available to meet the 24,000 AFY goal, so the facility size was capped assuming a 90% online factor).

f. 3 mgd of future flows to Renzel Marsh and potentially to horizontal levees and 0.3 mgd for losses in/around RWQCP (from 2015 Urban Water Management Plan)

g. Palo Alto and Sunnyvale AWPFs were sized to maximize production of purified water while also maintaining a reasonable AWPF efficiency, based on source flow availability. More details on flow availability and AWPF sizing are included in Appendix A-2.

h. 4 mgd for evaporation and capping at Sunnyvale's treatment ponds

mgd = million gallons per day

Treatment Level. The extent of treatment varies by AWPF and portfolio, based on the intended use of product water. The following types of reuse were considered in this analysis:

- **Non-potable reuse (NPR).** NPR systems in the County provide Title 22 disinfected tertiary recycled water for non-potable beneficial uses, such as landscape irrigation and industrial cooling.
- **Enhanced NPR, also referred to as NPR+.** To improve the quality of Title 22 recycled water for such uses, it can be blended with purified water (reverse osmosis [RO] treated or equivalent water quality).
- **Indirect potable reuse (IPR).** Characterized by use of an environmental buffer prior to becoming a potable water supply, IPR can be accomplished through groundwater recharge (**GWR**) or surface water augmentation (**SWA**).
- **Direct potable reuse (DPR).** Defined by the absence of a significant environmental buffer prior to becoming a potable water supply, DPR is accomplished through raw water augmentation (**RWA**) or treated water augmentation (**TWA**). Regulations for DPR are being developed and are anticipated by December 2023.

Delivery Point. Delivery points refer to locations where treated water would be conveyed for reuse (NPR or PR). The delivery points considered in this TM, grouped by treated water type, include:

- NPR/NPR+: New and existing NPR users throughout the County
- GWR: Los Gatos Recharge Ponds (LGRP) in North County and a combination of several percolation ponds in South County
- SWA: Valley Water's Anderson Reservoir[2] in South County, near Morgan Hill
- RWA: South Bay Aqueduct (SBA) terminal tank at Penitencia Water Treatment Plant (WTP)

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[2] If Anderson Reservoir is decommissioned in the future, other reservoirs may need to be considered (e.g., Calero Reservoir).

- TWA: North Side Storage Tanks to serve the City of Santa Clara and San José Municipal Water System (SJ Muni) water distribution systems, the Gibraltar Reservoir to convey treated water south along Valley Water's Milpitas Pipeline, the Piedmont Valve Yard to convey treated water north along Valley Water's Milpitas Pipeline or south along Valley Water's East Pipeline, and the West Pipeline to serve Valley Water customers in the western portion of the County.

Residuals Management

Though level of treatment varies, each potential AWPF is anticipated to consist of a process train that includes reverse osmosis (RO), which generates a concentrate stream. RO concentrate (ROC) management strategies vary depending on AWPF location and capacity. Valley Water is considering various management options as part of a ROC Management Plan (ROCMP) currently being developed in a parallel, separate project with the Master Plan. The ROCMP team is informing the feasible portfolios evaluation, specifically in terms of site-specific ROC management options, costs, and permitting complexity.

Conveyance/Distribution/Delivery Points

Conveyance and distribution project elements include:

- NPR/NPR+ distribution system expansions (based on retailers' previous studies)
- Interties between recycled water systems, including between Sunnyvale and SBWR and/or Sunnyvale and PA/MV
- Effluent pipelines from wastewater treatment plants (WWTP) to AWPFs for treatment
- Purified water pipelines from AWPFs to delivery points
- LGRP piping improvements
- Penitencia WTP improvements
- ROC pipelines
- Pump stations

Portfolio Development

The development of portfolios began in 2018 with identifying five conceptual portfolios and engaging Partner Agencies to select three conceptual portfolios and a variety of project elements for further development and evaluation.

The three portfolios selected for this evaluation each include a major PR project element(s) with source flow from the North County WWTPs, including the SJ/SC RWF, Palo Alto RWQCP, and Sunnyvale WPCP. Using source water from these facilities is the only way to potentially meet the 24,000 AFY PR goal. Treatment elements of the three portfolios are named using the potential facilities' locations and include:

- Portfolio 1: San José AWPF for GWR at LGRP, RWA at Penitencia WTP, or TWA in Santa Clara and San José distribution systems north of Highway 101 and turnouts along Valley Water's East Pipeline
- Portfolio 2: Combined Palo Alto/Sunnyvale Regional AWPF for GWR at LGRP
- Portfolio 4: Separate Palo Alto and Sunnyvale AWPFs for GWR at LGRP

NPR/NPR+ elements and South County project elements were evaluated separately and may be incorporated into any portfolio.

NPR/NPR+ Expansion (Featured in All Portfolios)

NPR expansion is expected to occur throughout the County. NPR can minimize the need to increase potable water system capacity and treatment. Relative to producing water for PR, NPR is often a lower-cost water supply.

The project team compiled information from recycled water retailers' Urban Water Management Plans (UWMP) about NPR expansion to sum the total 2040 NPR demand (Table ES-2).

Table ES-2. Summary of Projected Long-Term NPR Demands by Partner Agency

Partner Agency	Water Retailers	2040 NPR Demand		Current Contractual Obligation[b]
		mgd	AFY[a]	
PA/MV RWS	Palo Alto Mountain View	2.5	2,800	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	Sunnyvale Cal Water (Cupertino) San Jose Water (Cupertino)	1.5	1,700	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	Santa Clara SJ Muni San Jose Water Milpitas	27.6	30,900[c]	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline (through January 22, 2027, unless agreement is extended)
SCRWA	Gilroy Morgan Hill	3.3 2.6	3,700 2,900[d]	None
Countywide	Total, excluding Morgan Hill Total, including Morgan Hill	34.9 37.5	39,100 42,000[d]	

a. *Projected 2040 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY. For the City of Morgan Hill, NPR demand is equal to the conceptual buildout demand identified in the 2015 South County Recycled Water Master Plan Update. Long-term demands assume that any existing NPR is estimated into the future year UWMP demands, if applicable.*

b. *Projected NPR demands do not fully capture potential allocations per contractual agreements.*

c. *Reflects updated NPR demands provided by SBWR staff in January 2019.*

d. *Reflects Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.*

Portfolio 1 - San José AWPF

Portfolio 1 is centered on using available effluent from the SJ/SC RWF to feed a new AWPF adjacent to the existing Silicon Valley Advanced Water Purification Center (SVAWPC). Four treatment and delivery options were evaluated:

- Portfolio 1a – San José AWPF for GWR, which delivers up to 24,000 AFY to LGRP for groundwater replenishment.
- Portfolio 1b – San José AWPF for RWA, which delivers up to 24,000 AFY to the SBA terminal tank located immediately upstream of the Penitencia WTP.
- Portfolio 1c – San José AWPF for TWA, which delivers up to 24,000 AFY to local drinking water distribution systems in two directions: east to the North Side Storage Tanks serving the cities of San Jose and Santa Clara (portions north of Highway 101) and south to the existing Milpitas pipeline at the Gibraltar Reservoir. Purified water sent through the Milpitas pipeline could be blended with other treated water at the Piedmont Valve Yard and modulating valve vault near Penitencia WTP and conveyed to Valley Water turnouts along the East Pipeline.

- Portfolio 1d - San José AWPF for TWA, which delivers up to 24,000 AFY to local drinking water distribution systems in two directions: east to the North Side Storage Tanks serving the cities of San Jose and Santa Clara (portions north of Highway 101) and south (via a new pipeline parallel to the existing Milpitas pipeline) to the Piedmont Valve Yard near Penitencia WTP for delivery to Valley Water turnouts along the East Pipeline.

The differences among Portfolios 1a through 1d are summarized in Table ES-3.

Table ES-3. Portfolios 1a-1d Comparison of Key Attributes

Criteria	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d
Supply source	SJ/SC RWF			
AWPF design capacity	24 mgd			
Reuse type	GWR	RWA	TWA	TWA
Delivery point(s)	LGRP	Penitencia WTP	North Side Storage Tanks and Gibraltar Reservoir to send water south via existing Milpitas pipeline	North Side Storage Tanks and Piedmont Valve Yard to use East Pipeline
Anticipated yield (purified water)	24,000 AFY			
Purified water pump station - flow	16,700 gallons per minute (gpm)[a]			
Purified water pump station – total dynamic head (TDH)	400 feet (ft)	550 ft	250 ft to North Side Tanks 350 ft to Milpitas Pipeline	250 ft to North Side Tanks 350 ft to Piedmont Valve Yard
Conveyance pipeline	18.1 miles (48-inch)	8.9 miles (48-inch)	3.9 miles (36-inch) 4.7 miles (24-inch)	8.2 miles (36-inch) 4.7 miles (24-inch)
Delivery point improvements	4,700 ft of new pipeline (18-inch to 36-inch diameter)	3-million-gallon (MG) storage tank[b], chemical dosing system, and 66-inch blend pipe	n/a	n/a
ROC management strategy	Blend ROC with SJ/SC RWF effluent at a new outfall (including a new pump station and pipeline) that extends beyond the existing outfall weir.			

a. *1 gpm = 0.00144 mgd*

b. *3-MG storage tank is sized to provide about 3 hours' worth of operational purified water storage at Penitencia WTP. If the AWPF is offline, Valley Water could request a transfer from the State Water Project, which has an assumed 3- to 4-hour response time. (Valley Water, 2018a)*

Portfolio 2 - Combined Regional Palo Alto/Sunnyvale AWPF

Portfolio 2 is centered around combining available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for treatment at one AWPF that would provide regional benefit through GWR at LGRP. Sourcing one AWPF from two WWTPs (operated by two separate agencies) is not common and would likely involve unique interagency and regulatory circumstances. In addition, source flow availability is a key consideration for a Palo Alto and Sunnyvale-based portfolio, as total combined WWTP influents may not be sufficient to meet Valley Water's 24,000-AFY PR goal. Two options were evaluated:

- Portfolio 2a – Combined Regional AWPF in Palo Alto for GWR (LGRP)
- Portfolio 2b – Combined Regional AWPF on Sunnyvale AWPF Site for GWR (LGRP)

Both options are designed to deliver up to 23,000 AFY to LGRP for GWR. The differences between Portfolios 2a and 2b are summarized in Table ES-4.

Table ES-4. Portfolios 2a and 2b Comparison of Key Attributes

Criteria	Portfolio 2a	Portfolio 2b
Combined regional AWPF location	Palo Alto	Sunnyvale
AWPF design capacity	24.5 mgd (24 mgd for PR; 0.5 mgd for NPR+ in Sunnyvale)	24.5 mgd (24 mgd for PR; 0.5 mgd for NPR+ in Sunnyvale)
Reuse type	GWR	GWR
Delivery point	LGRP	LGRP
Anticipated yield (purified water)	17,300 - 23,000 AFY[a]	17,300 - 23,000 AFY[a]
Effluent Pipeline(s)	2.9-mile pipe from Palo Alto RWQCP; 7.4-mile pipe from Sunnyvale WPCP (36-inch diameter)	10-mile pipe from Palo Alto RWQCP (36-inch diameter)
Purified water pump station - flow	16,700 gpm[b]	16,700 gpm[b]
Purified water pump station - TDH	400 ft	400 ft
48-inch conveyance pipeline	20.3 miles	17.1 miles
Delivery point improvements	4,700 ft of new pipeline (18-inch to 36-inch diameter)	4,700 ft of new pipeline (18-inch to 36-inch diameter)
ROC management strategy	Use a new pipeline and pump station to convey ROC to the RWQCP for blending with effluent at the existing outfall.	Discharge ROC at a new shallow water outfall at Guadalupe Slough for enhanced mixing.

a. *Based on the range of projected influent using upper and lower bounds. See Section 2 and Attachment A for details.*

b. *1 gpm = 0.00144 mgd*

Portfolio 4 - Separate Palo Alto and Sunnyvale AWPFs for GWR

Portfolio 4 is centered on using available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for GWR at the LGRP. In this portfolio, two AWPFs would be constructed to use available flow from each WWTP. The Sunnyvale AWPF would be located on Recycle Hill, and the Palo Alto facility would be on the former Los Altos Treatment Plant (LATP) site located in Palo Alto. Key elements of Portfolio 4 are summarized in Table ES-5.

Table ES-5. Portfolio 4 Summary of Key Attributes

Criteria	Palo Alto AWPF (1 of 2 AWPFs)	Sunnyvale AWPF (2 of 2 AWPFs)
AWPF design capacity	14 mgd	10.5 mgd
Reuse type	GWR	GWR
Delivery point	LGRP	LGRP
Anticipated yield (purified water)	11,700 – 13,200 AFY	5,500 – 9,800 AFY
Combined yield (purified water)	17,300[a] - 23,000 AFY	17,300 [a] - 23,000 AFY
Purified water pump station – Flow[b]	9,720 gpm	6,950 gpm
Purified water pump station - TDH	130 ft	400 ft
Purified water conveyance	6.5-mile pipeline to Joint Purified Water Pipeline (36-inch diameter)	2.2-mile pipeline to Joint Purified Water Pipeline (36-inch diameter)
	13.7-mile Joint Purified Water Pipeline to LGRP (48-inch diameter)	13.7-mile Joint Purified Water Pipeline to LGRP (48-inch diameter)
Delivery point improvements	4,700 ft of new pipeline (18-inch to 36-inch diameter)	4,700 ft of new pipeline (18-inch to 36-inch diameter)
ROC management strategy	Use a new pipeline and pump station to convey ROC to the RWQCP for blending with effluent at the existing outfall.	Discharge ROC at a new shallow water outfall at Guadalupe Slough for enhanced mixing.

a. *Difference due to rounding.*
b. *1 gpm = 0.00144 mgd*

South County Reuse Options

To explore solutions to augment Morgan Hill's overall supply, the Project Team reviewed previous South County reuse work and developed new conceptual reuse options for consideration. South County reuse options may be incorporated into any of the portfolios.

The 2015 South County Recycled Water Master Plan (RWMP) (SCRWA, 2016) evaluated reuse alternatives for Morgan Hill, identifying NPR expansion near the SCRWA WWTP as the preferred option since conveying water north to Morgan Hill would require substantial energy. Recycled water service at the SCRWA facility is already challenged in meeting existing maximum day NPR demand in Gilroy (5.2 mgd in 2014), using most of the average dry weather influent flow (6.0 mgd in 2014).

The Master Plan is exploring several new project concepts, described below and summarized in Table ES-6.

- NPR+ delivered from the SBWR system, using a 5.8-mile extension originating near Metcalf Energy Center that could serve peak demands of up to 5 mgd to provide an estimated annualized NPR demand of up to 5,100 AFY in the Morgan Hill area.
- IPR via GWR, with water treated at a satellite WWTP and AWPF in Morgan Hill and then delivered to nearby percolation ponds within the Llagas Subbasin (for example, the San Pedro recharge ponds).
- IPR via SWA, with water treated at a satellite WWTF and AWPF in Morgan Hill and then delivered to the south end of Anderson Reservoir. A corresponding flow from the Santa Clara Conduit could be supplied to the San Pedro and/or Main Avenue ponds to benefit Morgan Hill's groundwater basin.
- DPR via TWA, with water treated at a satellite WWTF and AWPF in Morgan Hill and then delivered to the Morgan Hill drinking water distribution system.
- DPR via TWA, with water treated at a new AWPF adjacent to SCRWA in Gilroy and then delivered to the Morgan Hill drinking water distribution system.

Table ES-6. Overview of South County Reuse Options

Reuse Type	Source Flow	Delivery Point	Summary	Capital Cost ($2019 in millions)
NPR	SCRWA	New Morgan Hill NPR distribution system	Per the 2015 South County RWMP, extend pipeline parallel to existing joint sewer trunk line to convey recycled water from SCRWA in Gilroy to customers in Morgan Hill	$60[a]
NPR+	SBWR	New Morgan Hill NPR distribution system	Extend Silver Creek Pipeline from Metcalf Energy Center to customers in Morgan Hill; referred to as Morgan Hill Option 1 in this study and reflects full buildout of NPR to meet market demand.	$74[b]
GWR	Morgan Hill satellite WWTP and AWPF	San Pedro Ponds (assumed location for estimating costs)	Recharge Llagas Subbasin with purified water; referred to as Morgan Hill Option 2 in this study.	$130[b]
SWA	Morgan Hill satellite WWTP and AWPF	Anderson Reservoir	Pump purified water to Anderson Reservoir for blending and dilution, then recharge equal volume of raw water from the Santa Clara Conduit in Llagas Subbasin; referred to as Morgan Hill Option 3 in this study.	$150 [b]
SWA	SCRWA and Gilroy AWPF	Coyote Reservoir	Pump purified water from an AWPF at SCRWA (Gilroy) to Coyote Reservoir for blending and dilution. Coyote flows to Anderson Reservoir, allowing Morgan Hill to recharge equal volume from the Santa Clara conduit in Llagas Subbasin.	-- [c]
RWA	SCRWA and Gilroy AWPF	Pacheco Conduit	Pump purified water from an AWPF at SCRWA (Gilroy) to Pacheco Conduit for RWA at Santa Teresa and/or Rinconada WTPs, allowing Morgan Hill to recharge equal volume from the Santa Clara Conduit in Llagas Subbasin.	-- [c]
TWA	Morgan Hill satellite WWTP and AWPF	Morgan Hill engineered storage / potable distribution system	Deliver purified water from a satellite WWTP and AWPF in Morgan Hill to engineered storage, then to the Morgan Hill potable water distribution system.	-- [c]
TWA	SCRWA and Gilroy AWPF	Gilroy engineered storage / potable distribution system	Deliver purified water from an AWPF at SCRWA to engineered storage, then to the Gilroy potable water distribution system.	-- [c]

a. *Cost from SCRWA (2016) escalated to 2019 dollars.*
b. *Cost calculated as part of Master Plan (see Appendix A-6, Cost Estimates)*
c. *Not available*

Preliminary design of all AWPFs in this TM involve full advanced treatment (FAT), which require ROC management solutions. Valley Water's ROCMP team reported that the best option for managing ROC from a Morgan Hill AWPF would require 80 to 100 acres of lined evaporation ponds, though a location or cost for the evaporation ponds has not been identified.

Economic Assessment

Capital and annual O&M costs were estimated for each portfolio and form the basis for the 30-year and 100-year life-cycle assessments. The lifecycle costs consist of capital; replacement and renewal (R&R) of major equipment; and O&M of new treatment facilities, pump stations, pipelines, and water supplies. Table ES-7 summarizes estimated costs for each North County portfolio, and Table ES-8 summarizes estimated costs for each South County reuse option.

Table ES-7. North County Portfolios Economic Comparison Summary

	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4
AWPF Capacity (mgd)	24	24	24	24	24.5	24.5	24.5
Costs $2019 [a]							
Total Capital Cost [b]	$630M	$615M	$535M	$585M	$735M	$755M	$775M
Annual O&M Cost [b]	$18.4M	$18.9M	$21.4M	$21.5M	$19.4M	$18.6M	$20.2M
30-Year Life-cycle Costs							
R&R Cost [b]	$190M	$235M	$230M	$230M	$190M	$190M	$220M
Total Life-cycle Cost, Present Value [b]	$950M	$965M	$940M	$985M	$1,060M	$1,060M	$1,120M
Life-cycle Unit Cost ($/AF) [b,c]	$2,300/AF – $2,900/AF	$2,400/AF – $2,800/AF	$2,300/AF	$2,400/AF	$2,700/AF – $3,600/AF	$2,700/AF – $3,600/AF	$2,800/AF – $3,800/AF
100-Year Life-cycle Costs							
R&R Cost [b]	$1,045M	$1,185M	$1,165M	$1,190M	$1,105M	$1,085M	$1,200M
Total Life-cycle Cost, Present Value [b]	$1,320M	$1,360M	$1,365M	$1,415M	$1,450M	$1,440M	$1,535M
Life-cycle Unit Cost ($/AF) [b,c]	$1,800/AF –$2,300/AF	$1,900/AF – $2,300/AF	$1,900/AF	$2,000/AF	$2,100/AF – $2,800/AF	$2,100/AF – $2,800/AF	$2,200/AF – $3,000/AF

a. *The scope of this project includes Class 5 cost estimates. Per AACE International's criteria, expected accuracy for Class 5 estimates typically ranges from -50 percent to +100 percent. In developing preliminary (10 percent) designs, the Project Team collected quotes from equipment manufacturers for the AWPFs' treatment process systems, increasing the level of accuracy of AWPF costs consistent with Class 4 estimates (-30 to +50 percent). Capital costs are rounded up to $5 million. Annual O&M costs are rounded up to the nearest $100,000. Life-cycle unit costs are rounded to the nearest $100. All costs are presented in 2019 dollars*

b. *ROC management is not included in summary costs. See portfolio descriptions in Sections 3 and 4 for information on ROC management costs as estimated by GHD.*

c. *The range of unit costs represent the upper and lower bounds of assumed portfolio yield. See Appendix A-2 for additional detail on flow assumptions.*

Table ES-8. South County Reuse Options Economic Comparison Summary

	Option 1 (NPR+ from SBWR)	Option 2 (GWR)	Option 3 (SWA)
Supply yield (AFY)	2,900	1,900	1,900
Total Capital Cost [a, b]	$70M	$75M	$95M
Annual O&M Cost [a, b]	$2.6M	$6.8M	$7.3M
30-Year Life-cycle Costs			
R&R Cost [b,c]	$5M	$35M	$40M
Total Life-cycle Cost, Present Value [b,c]	$110M	$200M	$185M
Life-cycle Unit Cost ($/AF) [a, b,c,d]	$2,200/AF	$6,100/AF	$7,000/AF
100-Year Life-cycle Costs			
R&R Cost [b,c]	$20M	$170M	$185M
Total Life-cycle Cost, Present Value [b,c]	$145M	$315M	$350M
Life-cycle Unit Cost ($/AF) [a, b,c,d]	$1,700/AF	$5,400/AF	$6,000/AF

a. The scope of this project includes Class 5 cost estimates. Per AACE International's criteria, expected accuracy for Class 5 estimates typically ranges from -50 percent to +100 percent. In developing preliminary (10 percent) designs, the Project Team collected quotes from equipment manufacturers for the AWPFs' treatment process systems, increasing the level of accuracy of AWPF costs consistent with Class 4 estimates (-30 to +50 percent). Capital costs are rounded up to $5 million. Annual O&M costs are rounded up to the nearest $100,000. Life-cycle unit costs are rounded to the nearest $100. All costs are presented in 2019 dollars

b. ROC management is not included in summary costs. See portfolio descriptions in Section 3 for information on ROC management costs as estimated by GHD.

c. NPR+ distribution system for Option 1 is included in capital and O&M costs but not R&R costs. Lifecycle costs therefore do not reflect R&R costs for the NPR+ distribution system.

d. Lifecycle unit cost for Option 1 is based on the high end of the supply yield range.

Portfolio Evaluation and Risk Assessment Tool

The Master Plan explores various reuse strategies and is not intended to result in selection of a single recommended project. Thus, the Project Team created two tools to compare portfolios: an evaluation tool and a risk tool. The evaluation tool is used to compare portfolios relative to one another with respect to prioritization criteria identified by Valley Water and its Partner Agencies. Risks for each portfolio are assessed separately from the overall evaluation to provide a focused review of aspects that may disrupt, delay, or halt projects. The risk tool assesses the likelihood and consequence of each risk and compiles them into a composite risk score for each portfolio.

The evaluation tool compares the North County Portfolios with respect to quantitative criteria (e.g., costs, volume of PR water produced, and energy use), as well as qualitative criteria that were based on benefits and/or risk avoidance. NPR/NPR+ expansion and South County Reuse Options were evaluated separately, as these elements can be added to any portfolio.

Based on five criteria—economics, supply reliability, environmental benefits, ease of implementation, and engineering feasibility—Portfolio 1a scores highest regardless of criteria weighting scenarios and is the most "balanced" portfolio: it received some points for all criteria. The scores for Portfolios 1b, 1c, 1d, and 2a were the next highest scoring portfolios, though their scores were not well-balanced (meaning these portfolios performed very well for some criteria but not for others). For example, if more weight is given to the ease of implementation criterion, Portfolio 2a comes in second place to due to an existing long-term flows agreement between Valley Water and Palo Alto. However, if economics receives the most weight, Portfolio 1b comes in second place.

Appendix A-7: Evaluation and Risk Tool provides detailed descriptions of the approaches for developing the tools and how the project team uses them to compare portfolios.

Section 1: Introduction

A reliable supply of clean water is necessary for the environmental, economic, and social well-being of Santa Clara County (County). On behalf of the community, the Santa Clara Valley Water District (Valley Water), along with local partners, have made significant investments to manage demands for water as well as to develop water supplies and infrastructure to meet the County's water needs. As demands continue to grow and future supplies become more uncertain due to climate change, Valley Water intends to continue expanding these partnerships to develop locally controlled, drought-resilient supplies, such as water reuse.

Valley Water's Water Supply Master Plan 2040 (WSMP) recommends investment decisions to meet the County's 2040 water supply reliability goals in a cost-effective manner. One of the key strategies in the WSMP is expansion of water conservation and water reuse. These types of programs offer multiple benefits, including being locally controlled and drought-resilient, and are generally well supported by the community.

Valley Water's Board of Directors has established a goal to increase recycled water use from 18,000 acre-feet per year (AFY) as of 2018, such that water reuse meets 10 percent of total Countywide demands by 2025. As a result, the WSMP identified a goal of developing an additional 24,000 acre-feet per year (AFY) of reuse capacity, specifically potable reuse (PR) capacity, by 2028 (Valley Water, 2019b).

To assist in meeting these goals, Valley Water initiated development of the Countywide Water Reuse Master Plan (Master Plan) to integrate existing recycled water plans and infrastructure in partnership with four existing recycled water distribution systems serving non-potable reuse (NPR) in the County, referred to as Partner Agencies and including the following:

- **South Bay Water Recycling (SBWR).** Spanning multiple cities, the SBWR system has a more complex governance structure. Tertiary treated recycled water produced at the San José-Santa Clara (SJ/SC) Regional Wastewater Facility (RWF) is blended with advanced treated water produced at Valley Water's Silicon Valley Advanced Water Purification Center (SVAWPC). SBWR delivers this blended recycled water to the SBWR distribution system and wholesales it to four retailers: (1) the City of Milpitas, (2) the City of Santa Clara, (3) SJ Muni, and (4) San Jose Water (SJW).
- **Palo Alto/Mountain View (PA/MV) Recycled Water System (RWS).** The Palo Alto Regional Water Quality Control Plant treats wastewater from the communities of Los Altos, Los Altos Hills, Mountain View, Palo Alto, Stanford University, and the East Palo Alto Sanitary District and sends tertiary treated recycled water to the PA/MV RWS. Palo Alto and Mountain View each distribute retail recycled water to customers within their city limits.
- **City of Sunnyvale.** The City of Sunnyvale manages the Sunnyvale recycled water program, which consists of production/operation, distribution, permitting, and monitoring of the Sunnyvale RWS. Sunnyvale is the producer, wholesaler, and retailer for recycled water, except for select service from the Wolfe Road pipeline where Valley Water is the wholesaler and California Water Service Company (Cal Water) is the retailer.
- **South County Regional Wastewater Authority (SCRWA).** SCRWA is a joint powers authority created by the cities of Gilroy and Morgan Hill to manage wastewater treatment. An agreement among SCRWA, Valley Water, and the cities of Gilroy and Morgan Hill establishes SCRWA as the NPR producer, Valley Water as the wholesaler, and the cities of Gilroy and Morgan Hill as the retailers. The City of Gilroy currently retails recycled water. Recycled water facilities are not yet within Morgan Hill.

The Master Plan will provide a framework to make collaborative decisions and implement integrated actions to increase the region's water supply reliability through water reuse, as applied to a planning horizon through 2040. Objectives of the Master Plan include:

1. **Determine reuse supply availability and benefits.** Identify sources and amounts of water available for reuse; the appropriate split between NPR and PR; and regional, Valley Water, and local-level benefits from NPR and PR.

2. **Evaluate potential regional integration.** Facilitate innovative approaches and collaboration for residuals management, permitting, and land use decisions. Optimize use of supply and infrastructure, improve system reliability and flexibility, and explore redefining sewersheds.
3. **Guide system expansion through interagency agreements and governance.** Analyze the economics of project alternatives and explore cost-sharing opportunities.
4. **Solicit input and generate regional support for the Master Plan via coordination and stakeholder outreach.** Improve public perception of water reuse through outreach programs.

The Master Plan will present several portfolios of potential future projects, along with related information that may support potential future interagency agreements and governance.

This Feasible Project Portfolios Technical Memorandum (TM) is an interim deliverable that builds on the Conceptual Alternatives TM (Appendix F), which assessed five portfolios and identified three to carry forward for feasibility analysis. This TM further defines project elements—essentially the building blocks of the three portfolios—to a preliminary (10 percent) design level and serves as a critical foundation for the Master Plan.

The portfolios are each composed of sets of project elements in two general categories: conveyance/ distribution facilities (i.e., pipelines and pump stations) and treatment facilities. The treatment facilities are distinguished by the following characteristics:

- **Source water.** Origin (agency/facility) of wastewater for reuse.
- **Treatment level.** Extent of treatment, based on type of reuse (e.g., NPR, groundwater recharge [GWR], surface water augmentation [SWA], raw water augmentation [RWA], or treated water augmentation [TWA]).
- **Delivery point.** Facility/location where treated product water would be delivered for reuse (NPR or PR).

To assess the three portfolios, the portfolios were evaluated by comparing them to one another based on the following criteria:

- **Economics**, including a comparison of each portfolio's total unit cost (e.g., cost per acre-foot [$/AF]) reflecting capital, operations and maintenance (O&M), and replacement (over an extended time period) costs of new treatment and conveyance facilities; estimated 30- and 100-year life-cycle costs as a present value; funding capability; and grant funding eligibility.
- **Groundwater management and countywide supply reliability,** including a comparison of each portfolio's potable reuse water supply (AFY) based on 2040 estimated flows and design capacity; the number of delivery points included in the portfolio; seasonality of PR supply and delivery point capacity; the dry year drought reliability; and the ability to protect groundwater basin quality.
- **Environmental benefits/impacts and sustainability,** including energy consumption, used as a proxy for reducing carbon footprint and greenhouse gas (GHG) emissions; environmental protection, from a discharge and ROC management perspective; and environmental protection, from a more general California Environmental Quality Act (CEQA) and National Environmental Protection Act (NEPA) perspective.
- **Ease of implementation and permitting/regulatory considerations,** including each portfolio having willing partner(s) interested in collaborating, providing ownership of wastewater, offering operational simplicity, minimizing difficulty in obtaining permits for PR, minimizing difficulty in obtaining permits for environmental regulations (including ROC management and CEQA), being ready to proceed/reducing delays, gaining public acceptance/support, and supporting environmental and social justice/equity.
- **Engineering feasibility,** including using tested and proved technology, and meeting other water quality requirements without difficulty, such as source control and/or monitoring requirements.

Additionally, risk avoidance is built into the above evaluation criteria, as several of the sub-criteria (included under the above criteria in bold) represent ways of minimizing or avoiding risk rather than providing direct benefits.

1.1 Types of Reuse

The portfolios described in this TM include the following types of reuse.

- **NPR.** NPR systems in the County provide Title 22 disinfected tertiary recycled water for non-potable beneficial uses, such as landscape irrigation and industrial cooling.
- **Enhanced NPR, also referred to as NPR+.** To improve the quality of Title 22 recycled water for such uses, recycled water can be enhanced by blending with purified water (RO treated or equivalent water quality).
- **Indirect Potable Reuse (IPR).** Characterized by use of an environmental buffer prior to becoming a potable water supply, IPR can be accomplished through **GWR** via surface spreading, GWR via direct injection, or **SWA**. While all three forms of IPR are currently regulated in California, Valley Water is not considering GWR via direct injection at this time, based on findings from the Expedited Purified Water Program Plan that indicate unfavorable O&M requirements.
- **DPR.** Defined by the absence of a significant environmental buffer prior to becoming a potable water supply, DPR is accomplished through **RWA** or **TWA**. DPR projects have significantly reduced time to detect and respond to failures or compromises in treatment prior to distribution. Regulations for DPR are being developed and are anticipated by December 2023.

1.2 Regulatory Setting

Given the wide range of reuse scenarios considered in the Master Plan, a spectrum of permitting requirements applies. While source water quantity, intended end uses, and production goals have shaped the portfolios, permitting requirements will likely drive treatment process selection and other considerations, such as degree of wastewater treatment; monitoring and response capabilities; source-control program requirements; and technical, managerial, and financial capacities. The Regulatory Framework TM (Appendix B-2) provides a detailed overview of the regulatory framework for various types of reuse in California, and the following sections summarize the permitting requirements that shaped the treatment process designs in this TM. The Master Plan will include recommended strategies for regulatory compliance for the portfolios.

1.2.1 Environmental Requirements

Regional Water Quality Control Boards (Regional Boards) implement water quality planning and regulatory decisions for their specific regions, such as issuing waste discharge requirements (i.e., discharge permits) and administering National Pollutant Discharge Elimination System (NPDES) permits for receiving surface water bodies and enforcing Salt and Nutrient Management Plan (SNMP) requirements for groundwater protection.

NPDES permits for discharges to surface waters contain specific requirements that limit the pollutants in discharge effluent. The San Francisco Bay (SF Bay) Regional Board (SF Bay; Region 2) regulates discharge facilities in the northern part of County (North County), while the Central Coast (CC) Regional Board (CC; Region 3) regulates SCRWA's discharges in the South County. Regional Boards are responsible for specific regulatory responsibilities affecting water reuse, such as:

- Approving pollutant source control programs for wastewater systems
- Issuing and enforcing water reclamation (reuse) requirements to producers and users
- Defining beneficial uses of surface water and groundwater bodies through water quality control plans
- Regulating treatment facility operators

- Determining water rights regarding reuse

In context of the Countywide program, three contemplated activities may trigger the need to seek new or modified NPDES permits through Regional Boards, including discharging: (a) purified water to spreading basins for GWR; (b) purified water to Anderson Reservoir for SWA; and/or (c) RO concentrate (ROC) through surface water outfalls. Most PR applications in California use full advanced treatment (FAT), producing significant volumes of ROC that may contain concentrated levels of total dissolved solids (TDS), nutrients, metals, and toxicity. Depending on the circumstances, reuse projects that discharge ROC to surface water may require a new NPDES individual permit, a modification of an existing NPDES permit, or an industrial permit if discharged into an existing sewer system. The latter would require coordination and agreement with the municipality that manages the respective sewer system. Routing ROC streams to existing outfalls requires careful review of potential impacts to existing NPDES permits to determine whether the ROC stream may compromise compliance with effluent discharge water quality requirements and whether further waste stream treatment and/or permit modifications are needed.

SNMPs establish pertinent water quality objectives (WQO) to protect groundwater quality from potential degradation. NPR for irrigation has the potential to increase salts and other contaminants in groundwater, though it is not expected to be a significant source of salt loading relative to other sources.

1.2.2 Potable Reuse

Permitting requirements differ across specific types of PR. In many cases, these differences are linked to the existence and size of an environmental buffer. As the buffer diminishes in size—or is eliminated in many DPR scenarios—regulatory requirements for other project components increase. Environmental buffers provide myriad benefits—less stringent wastewater and advanced water purification facility (AWPF) treatment requirements (due to the attenuation of contaminants in the environment), dilution to minimize potential chemical contaminant peaks, and/or decreased monitoring requirements due to increased response time.

The least direct form of PR—GWR via surface spreading or direct injection—has been practiced in California the longest, with the first successful IPR project starting in 1962. More than 50 years later, in 2014, the State finalized GWR regulations. The extended period between initial GWR implementation and final regulations provided regulators an opportunity to learn how to protect public health while fostering the growth of this alternative water supply. Recently finalized in 2018, SWA regulations developed more quickly, yet still benefited from the lessons learned and process of developing GWR regulations.

The variation in SWA regulations exemplifies how current regulations require increasing levels of treatment with smaller environmental buffers. As dilution and retention time in a reservoir decreases, pathogen log reduction values (LRV) increase, highlighting the link between the required level of treatment and amount of protection the environment provides. Pathogen reduction requirements can help determine treatment process selection and, therefore, have a large impact on AWPF design decisions. For example, additional advanced treatment processes are included to account for protections lost by minimizing time between treatment and consumption.

Figure 1-1 summarizes the forms of potable reuse and their minimum requirements as dictated by state regulations. As the environmental buffer becomes less significant—providing less dilution and/or retention time—the LRVs required increase for the target pathogens, including viruses, *Giardia* cysts, and *Cryptosporidium* oocysts (V/G/C).

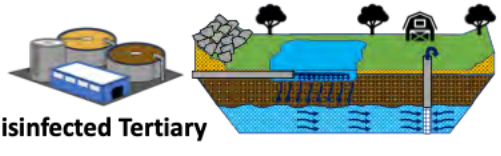
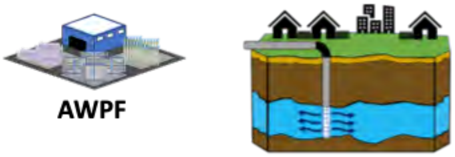
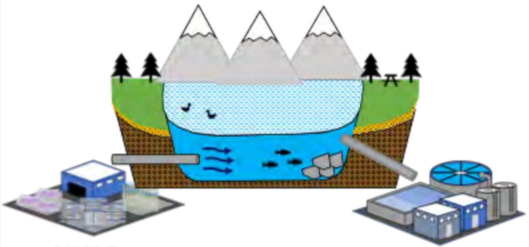
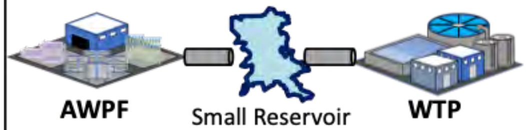
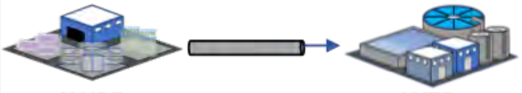
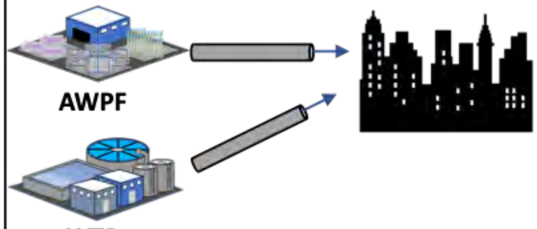
	Configuration	LRV Requirements V/G/C	Additional Considerations
Indirect Potable Reuse	**Groundwater Recharge – Surface Spreading**  	**12/10/10** • Retention time typically ≥ 6 mos.	• Final regulations in 2014 • Does not require FAT • Typically relies on aquifer for V/G/C credit and additional chemical control
	Groundwater Recharge – Direct Injection  	**12/10/10** • Retention time ≥ 2 mos.	• Final regulations in 2014 • Requires FAT train • Typically relies on aquifer for virus credit
	Surface Water Augmentation  	**12/10/10** • Min. dilution 100-to-1 • Reservoir V/Q > 4 mos. **13/11/11** • Min. dilution 10-to-1 • Reservoir V/Q > 4 mos. **14/12/12** • Min. dilution 10-to-1 • 4 mos. > V/Q > 2 mos.	• Final regulations in 2018 • Requires FAT train • No pathogen credits for reservoir storage
Direct Potable Reuse	**Raw Water Augmentation**  	**TBD**	• Final regulations in 2023 • Likely to require FAT plus additional treatment • Additional requirements anticipated for source control, wastewater treatment, chemical control, monitoring, operations, blending, diversions, and other topics.
	 	**TBD**	
	Treated Water Augmentation  	**TBD**	

Figure 1-1. Summary of PR forms and associated pathogen reduction requirements

In general, the requirements for the control of toxic chemicals are equivalent across the various forms of IPR, with the GWR and SWA regulations requiring both effluent monitoring to verify compliance with all regulated chemicals and a suite of unregulated contaminants (including constituents of emerging concern [CEC]), as well as surrogate monitoring to confirm treatment train performance. The requirements for chemical monitoring continue to evolve, including the notable recent addition of a bioassay requirement in the State Water Resources Control Board's (State Board) Recycled Water Policy. The FAT train provides treatment for specific chemicals and is capable of meeting these requirements for many IPR applications.

In DPR—including both RWA and TWA—the environmental buffer may be significantly reduced or eliminated compared to IPR. Consequently, there may be enhanced requirements for pathogen control, chemical attenuation, real-time monitoring, engineered storage, and blending (Figure 1-1). Though regulations for RWA and TWA have not yet been developed, potential future requirements can be inferred from recent publications and presentations from the State Water Resources Control Board's Division of Drinking Water (DDW), the California DPR Expert Panel, and the Project Team's engagement in DPR research and permitting. A more in-depth evaluation of regulatory compliance for the portfolios' potable reuse elements will be provided in the Draft Master Plan.

Under legislative mandate in Assembly Bill (AB) 574, the State Board is required to develop regulations for RWA by the end of 2023 (with a potential extension to mid-2025). In August 2019, the State Board issued the second edition of its Proposed Framework for Regulating DPR in California, with various updates to their initial draft.

Notably, the State Board has indicated the intent to develop a single DPR regulatory package that encompasses requirements for both RWA and TWA. The timeline for the DPR regulatory package remains consistent with the Assembly Bill (AB) 574 deadline of December 2023. In marked contrast with earlier potable reuse regulations, the revised DPR regulations will require treatment to consistently meet a daily risk objective versus an annual risk objective. This shift will likely increase the LRV requirements for DPR applications, though the specific criteria are still under development.

Currently, the State Board is funding priority DPR research topics to address knowledge gaps identified as critical for regulatory development. Leveraging this research, the State Board has also indicated that it will set DPR regulations focused on "…ensur[ing] the public's health is reliably protected at all times." These considerations will impact the design of various elements in the feasible project alternatives—from source control to treatment, monitoring and operations, diversions, and alternative supplies (Table 1-1).

Table 1-1. Approaches to maintain public health protection in DPR settings

Approach	Description
Source Control	Source control is a management barrier that provides a first layer of protection against toxic chemicals. It controls chemical risks by reducing concentration and variability of chemicals entering an AWPF. Compared to IPR, more stringent source control requirements will apply to DPR due to lack of an environmental buffer.
Wastewater Treatment	Consistent AWPF performance is enabled by upstream wastewater treatment that provides a consistently high-quality feedwater to AWPFs. The State Board and DPR Expert Panel recommend minimum criteria for wastewater treatment plants (WWTP) serving as source water to a DPR system, including a high degree of organics destruction (e.g., secondary processes providing biological nutrient removal) and tertiary filtration prior to the AWPF.[a b c] Other beneficial elements include management of flows into the system and rigorous process monitoring.
Pathogen Control	Pathogens represent the most important public health concern because a single exposure can result in a public health impact. The State will require additional redundancy in pathogen control for DPR, possibly extending beyond IPR requirements and based on complying with a daily risk goal (instead of annual risk goal used for IPR). Barriers include treatment and management (non-treatment) approaches.
Chemical Control	DPR trains will likely need to provide additional control measures—including treatment—to attenuate chemical peaks and provide added protection against compounds known to pass through FAT trains[a] and unknown compounds with similar characteristics.
Response Time and Failures	In IPR settings, an environmental buffer enables more time for identifying failures and responding appropriately. With DPR retention time being hours (not months), DPR requires moving toward greater failure prevention and configuring elements of a DPR system—including monitoring, diversions, storage, treatment, automated controls, and operator training—to achieve a balance that protects public health without much failure response time.

a. *State Water Resources Control Board (2016)*
b. *State Water Resources Control Board (2019)*
c. *Tchobanoglous et al (2015)*

1.3 Environmental Setting

Following development of the Master Plan, Valley Water intends to prepare a programmatic Environmental Impact Report (EIR) to describe the environmental impacts of the project elements and portfolios. This approach affords an approval process that gives the flexibility to proceed with implementing individual project elements or portfolios.

Some environmental factors—such as GHG emissions, energy use, and discharge water quality, quantity, location, and timing—vary across project portfolios due to the number and size of proposed AWPFs, length of pipelines, pumping requirements, ROC management strategies, and other factors. At this current planning-level phase, other CEQA-required considerations are generally consistent among portfolios, including biological resources, geology, soils, fisheries, land use, cultural resources, noise, air quality, traffic, hazardous materials, aesthetics, economic justice, and growth inducement. As more information becomes available about each project portfolio, other CEQA-required considerations may become differentiators when programmatic EIR is being prepared.

Section 2: Project Elements

This section summarizes preliminary (10 percent) design details of the project elements, including treatment facilities, conveyance/distribution facilities (i.e., pipelines and pump stations), delivery point improvements (e.g., LGRP piping), and conceptual cost estimates. More detailed information on elements to complement this section is included in other appendices, as follows.

- Appendix A-2: Compendium of flow assessments, facility design capacity, and annual yield calculations
- Appendix A-3: Treatment facilities' design criteria and sizing calculations
- Appendix A-4: Process flow diagrams and site layouts
- Appendix A-5: Basis of costs for project elements (i.e., inputs, assumptions, methods, and sources)
- Appendix A-6: Conceptual estimates for project elements' costs (i.e., line-item costs for AWPFs, pump stations, pipelines, and system interties)
- Appendix A-7: Expanded evaluation and risk assessment
- Appendix A-8: TWA Pre-screening analysis
- Appendix B: Regulatory compliance
- Appendix C: Hydraulic modeling
- Appendix D: Project definition, roles, and responsibilities
- Appendix E: Baseline analysis
- Appendix F: Conceptual alternatives
- Appendix G: ROC management strategies

Cost estimates were developed using information from vendor quotes specific to proposed facilities, historical construction estimates and cost data, and professional experience with similar projects. Capital costs include construction-related materials and equipment costs, tax, contractor overhead and profit, owner's reserve for change orders, construction management, and engineering services for design and construction. The O&M costs include consumables (such as membranes, ultraviolet (UV) lamps, UV ballasts, and decarbonator tower media), energy/power, chemicals, and labor.

The scope of this project includes Class 5 cost estimates. Per AACE International's criteria, expected accuracy for Class 5 estimates typically ranges from -50 percent to +100 percent. In developing preliminary (10 percent) designs, the Project Team collected quotes from equipment manufacturers for the AWPFs' treatment process systems, increasing the level of accuracy of AWPF costs consistent with Class 4 estimates (-30 to +50 percent).

2.1 Treatment Facilities

The reuse treatment facilities are distinguished by the following characteristics:

- **Source water.** Origin (agency/facility) of wastewater for reuse.
- **Treatment level/type of reuse.** Extent of treatment, based on type of reuse; types of reuse considered for project elements in this TM include NPR, NPR+, GWR via surface spreading, SWA, RWA, and TWA.
- **Delivery point.** Facility/location where treated product water would be delivered for reuse (NPR or PR).

Partner Agencies produce recycled water for NPR at existing treatment facilities, and each have established plans for continued future use. As such, the treatment elements explored in this TM include AWPFs for NPR+, GWR, SWA, RWA, and TWA as summarized in Table 2-1.

Table 2-1. Project Elements: Treatment Facilities

Description	Source Water Facility(ies)	Treatment Level/ Type of Reuse	Delivery Point	Design Capacity (mgd)[a]	Treatment Processes
San José AWPF (pending future NPR+ demands and potential source of Morgan Hill NPR+)	SJ/SC RWF	NPR+	SBWR distribution system	8	Microfiltration (MF), RO, UV (FAT process)
San José AWPF	SJ/SC RWF	GWR	LGRP	24	FAT process
San José AWPF	SJ/SC RWF	RWA	Penitencia Water Treatment Plant (WTP) (as operations necessitate, LGRP and Rinconada WTP serve as supplementary delivery points)	24	FAT process plus ozone-biologically active carbon (O_3-BAC)
San José AWPF	SJ/SC RWF	TWA	Local distribution conveyed through either the Milpitas pipeline or a new pipeline to the treated Piedmont Valve Yard at Penitencia WTP	24	FAT process plus O_3-BAC and chlorine disinfection
Local Palo Alto AWPF	Palo Alto RWCQP	NPR+	PA/MV RWS distribution system	2.25	Microfiltration/ultrafiltration (MF/UF), RO, disinfection
Local Sunnyvale AWPF (only needed if intertied to PA and SBWR)	Sunnyvale Water Pollution Control Plant (WPCP)	NPR+	Sunnyvale RWS distribution system	1.2	MF/UF, RO, disinfection
Combined Regional AWPF in Palo Alto at the former LATP site	Palo Alto Regional Water Quality Control Plant (RWQCP) and Sunnyvale WPCP	GWR	Los Gatos Recharge Ponds (LGRP)	24.5 (24 for GWR; 0.5 for NPR+)	FAT process with equalization basin
Combined Regional AWPF in Sunnyvale at Recycle Hill	Palo Alto RWQCP and Sunnyvale WPCP	GWR	LGRP	24.5 (24 for GWR; 0.5 for NPR+)	FAT process with equalization basin
Separate Regional AWPF in Palo Alto at the former LATP site	Palo Alto RWQCP	GWR	LGRP	14	FAT process with equalization basin
Separate Regional AWPF in Sunnyvale at Recycle Hill	Sunnyvale WPCP	GWR	LGRP	10.5 (10 for GWR; 0.5 for NPR+)	FAT process with equalization basin
Morgan Hill satellite plant and AWPF	Morgan Hill	GWR and SWA	Anderson Reservoir (for blending, dilution, and subsequent treatment at a Valley Water WTP	2	FAT process with membrane bioreactor (MBR)

a. Design capacities are for determining feasibility and do not reflect contractual flow agreements. For example, the design capacity of the separate regional AWPF in Palo Alto is listed as 14 mgd, though the contractual agreement between Palo Alto and Valley Water establishes a minimum supply guarantee of 9 mgd for purification at a regional AWPF.

b. State Water Resources Control Board (2019)

mgd = million gallons per day

2.1.1 Source Water

The project elements and portfolios consider partnerships with the agencies producing NPR from four municipal WWTPs in the County, including:

- SJ/SC RWF
- Palo Alto RWQCP
- Sunnyvale WPCP
- SCRWA

Currently, some portion of wastewater effluent from these facilities is recycled for NPR and, in Palo Alto, sent to wetlands for environmental benefit. Remaining effluent in North County is discharged to the San Francisco Bay, while remaining effluent in South County is sent to percolation ponds or discharged to the Pajaro River (toward Monterey Bay). The feasible portfolios explore options that use a portion of the County's projected remaining effluent as source water for additional reuse (both PR and NPR). In addition, an option being considered for Morgan Hill involves satellite treatment—an approach where raw wastewater would be diverted from the SCRWA collection system.

Table 2-2 summarizes projected influent flow at each WWTP, shown as average dry weather flow (ADWF), or the lowest consecutive three-month average. To account for the uncertainty in future influent projections (e.g., changes in water use/land use and population growth/density), a range of flow is presented. The lower bound assumes influent remains constant, using the average of monthly median flows from 2014 to 2018 as the baseline. The upper bound uses the same baseline but assumes flows increase at the rate projected in individual agencies' wastewater or recycled water master plans through 2035. (In cases where multiple flow projection curves were provided, the flattest slope was selected.)

Table 2-2. Range of Projected 2035 WWTP Influent Flows [a]

WWTP	Projected ADWF (mgd), using 2014-2018 baseline[b]	
	Lower Bound: Flatlined Projection	Upper Bound: Increasing ADWF[c]
SJ/SC RWF	98.4	106
Palo Alto RWQCP	17.7	19.6
Sunnyvale WPCP	11.2[d]	15.9
SCRWA	6.0	6.0

a. Although 2040 is the planning horizon for the Master Plan, 2035 was used for the flow analysis based on projections available in Partner Agencies' planning documents. Using 2035 also provides a more conservative estimate of available flow, since influent will likely remain constant or increase between 2035 and 2040 (according to current projections).

b. ADWF was calculated using average of monthly median flows from 2014-2018. Influent flow data was downloaded from the California Integrated Water Quality System (CIWQS) database.

c. Rate of increase based on slopes from individual agencies' influent projection curves (in past wastewater or recycled water plans)

d. Actual Sunnyvale WPCP influent is approximately 0.5 mgd lower than the values reported in CIWQS, due to a difference in metering location. Values shown in Table 2-1 account for this by subtracting 0.5 mgd from the CIWQS data.

Figures 2-1 through 2-3 show the lower and upper bound ADWF range for the three North County WWTPs in comparison to projections from previous planning studies. Figures 2-1 and 2-2 overlay existing figures from SBWR and Palo Alto, respectively. SCRWA WWTP influent was already projected to remain constant over time (at approximately 6 mgd); so, flatlining the projections makes no significant difference in South County.

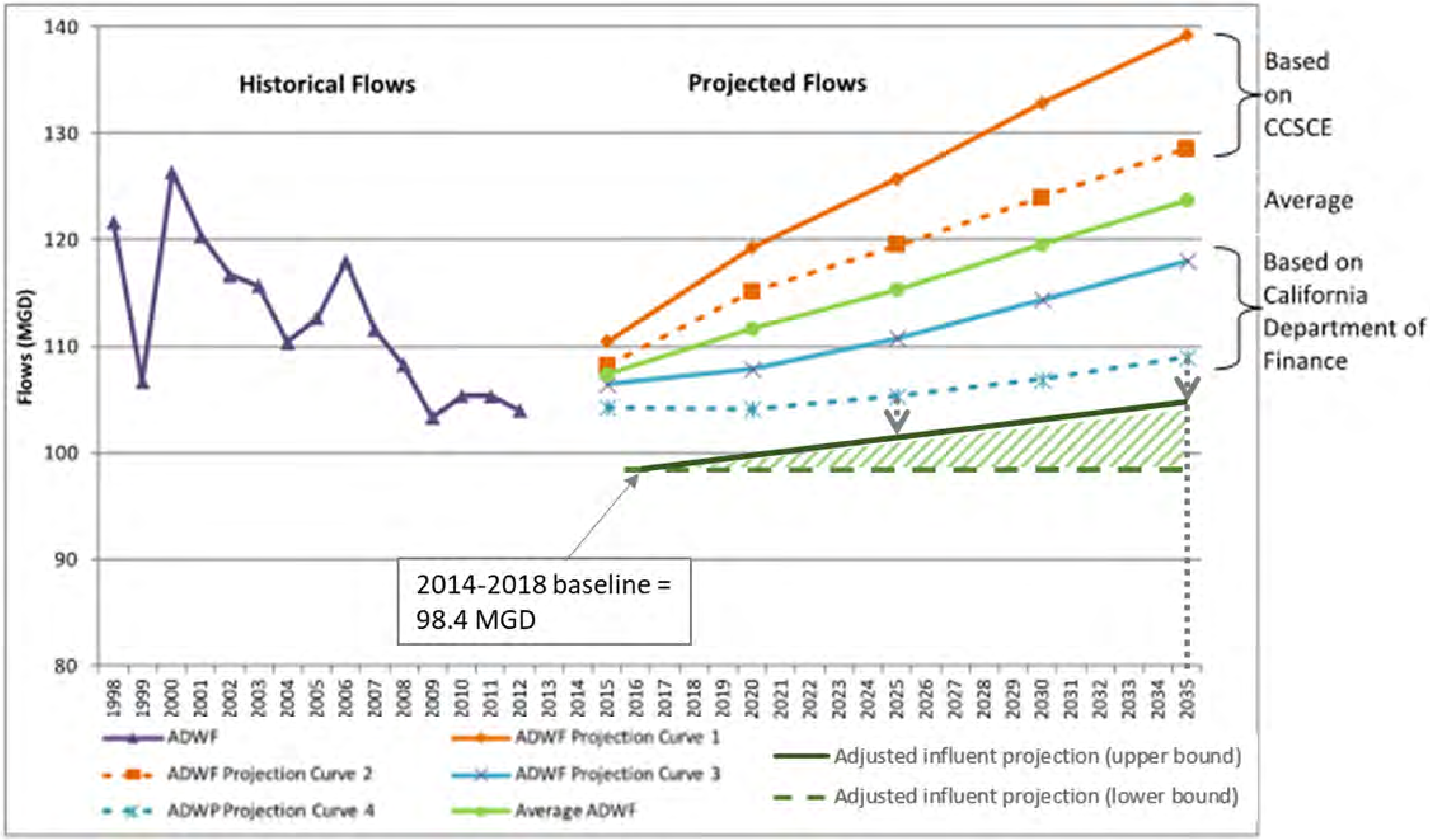


Figure 2-1. Dry-weather influent projections from the SBWR Strategic and Master Planning Report, with adjusted flow range

Source: SBWR, "Strategic and Master Planning Report." December 2014.

Note: The adjusted influent projection lines overlay the original figure from SBWR's Strategic and Master Planning Report.

CCSCE = Center for the Continuing Study of the California Economy

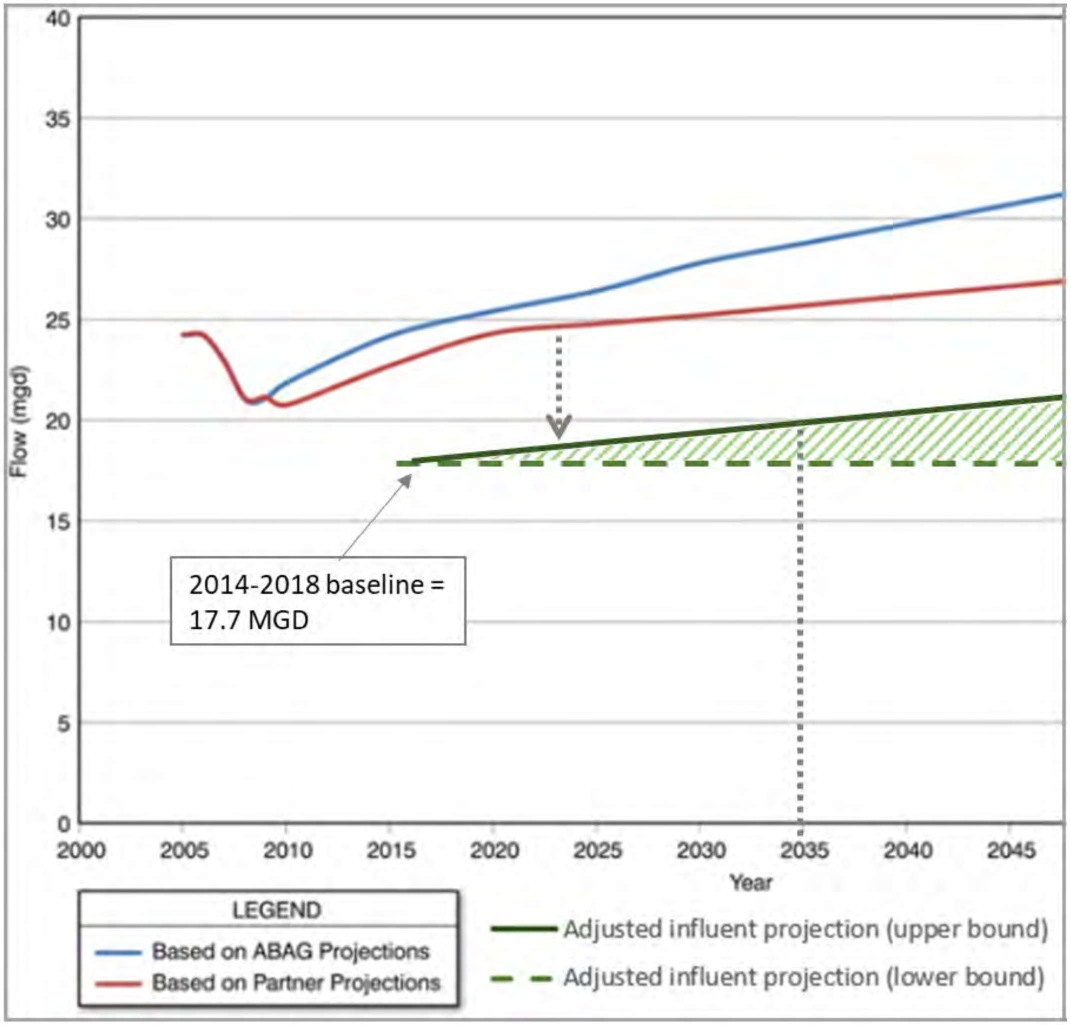


Figure 2-2. Dry-weather influent projections from the Palo Alto Long-Range Facilities Plan, with adjusted flow range

Source: City of Palo Alto, "Long Range Facilities Plan for the Regional Water Quality Control Plant." October 2012.

Note: The adjusted influent projection lines overlay the original figure from Palo Alto's Long-Range Facilities Plan.

ABAG = Association of Bay Area Governments (regional land use and transportation planning agency)

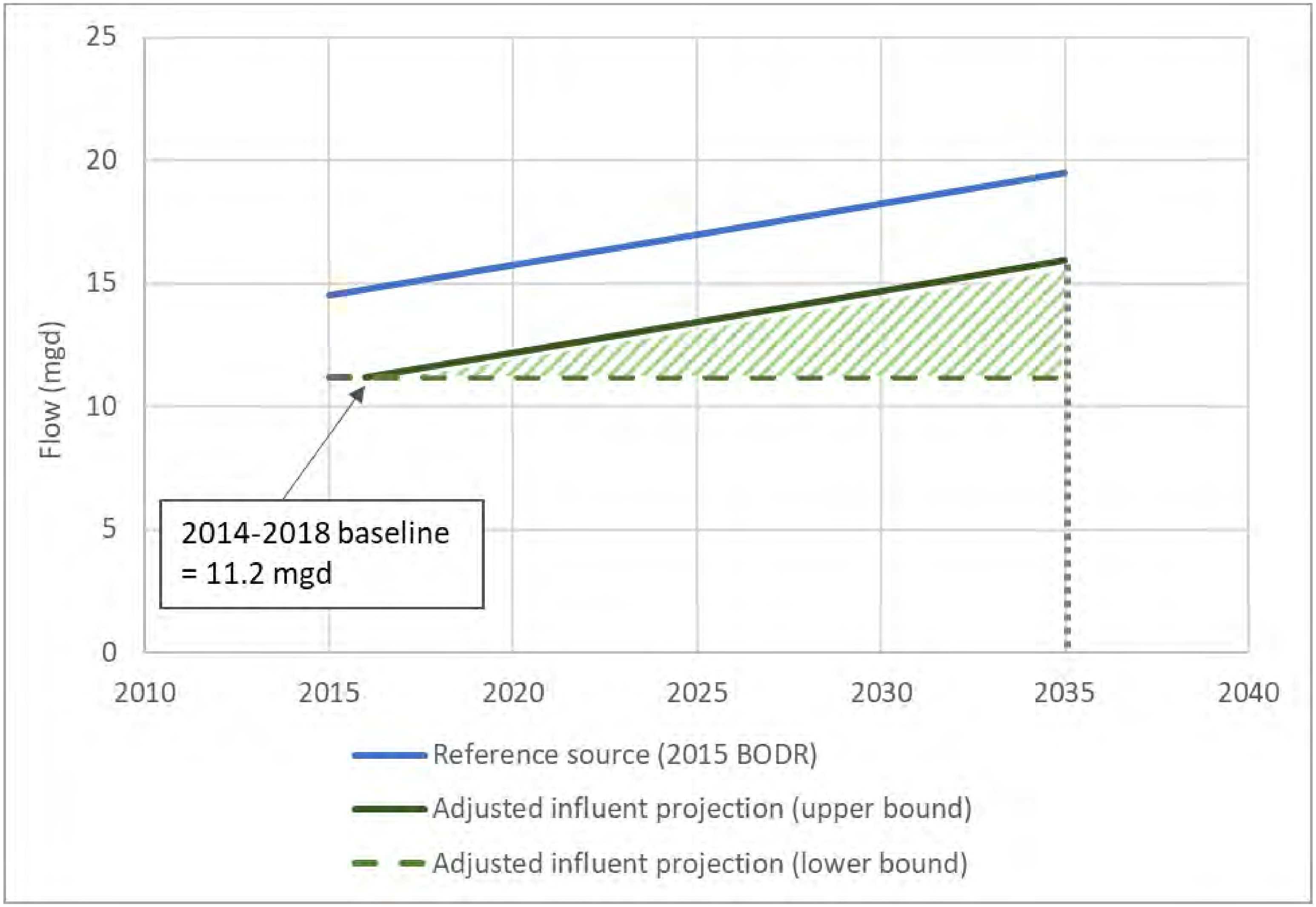


Figure 2-3. Dry-weather influent projections from the Sunnyvale WPCP Basis of Design Report (BODR), with adjusted flow range

Source: City of Sunnyvale, "Simultaneous Production of Recycled Water." Basis of Design Report. July 15, 2015. Prepared by HDR.

Future ADWF was converted to monthly flow projections based on the seasonal variation of historic flows. Using the 2035 lower and upper bound monthly flows, a PR yield evaluation was performed to assess the potential water supply outcome for each facility. The PR yield evaluation accounted for a variety of flow commitments and/or allocations of flow, including:

1. Losses/uses around the WWTP (e.g., Palo Alto RWQCP onsite use, capping at the Sunnyvale WPCP ponds)
2. Environmental flows (e.g., Palo Alto future flows to Renzel Marsh and potentially to horizontal levees)
3. Projected future NPR demand
4. Advanced treatment process losses (i.e., ROC) for NPR+

These commitments and allocations were subtracted from the projected influent to determine the remaining effluent available for PR or other purposes (e.g., discharge, blending). The evaluation considered monthly flow availability, and a sensitivity analysis of AWPF capacities for PR was used to identify AWPF capacity and associated yield at each facility. Table 2-3 summarizes average annual flows and potable reuse yields for each of the North County facilities, based on this evaluation. A more detailed summary of the evaluation, including monthly flows by Partner Agency, is included in Appendix A-2.

Table 2-3. Summary of Flow and Yield Evaluation (Projected Annual Flows)

	Annual Average Flows		NPR Flows		PR Flows (at selected capacity)[a]		
Location	Future Influent (mgd)	Losses/ Environmental Flows (mgd)	Future NPR Demands (mgd)	ROC from NPR+ (mgd)	Available Effluent for PR[b] (mgd)	Average Purified Water Production (mgd)	Annual Purified Water Yield (AFY)
SJ/SC	100.5 to 108.2	--	27.6[c]	1.8[d]	71 to 78.7	21.6[e]	24,000[e]
Palo Alto	19.3 to 21.3	3.3[f]	2.5	0.2	13.3 to 15.3	10.5 to 11.8[g]	11,700 to 13,200 [g]
Sunnyvale	11.9 to 16.9	4.0[h]	1.5	0.1	6.3 to 11.3	4.9 to 8.8[g]	5,500 to 9,800[g]
Morgan Hill	--	--	--	--	2.1	1.7	1,900

a. Selected AWPF capacities for PR (does not include additional capacity needed for NPR+): (1) Sunnyvale, 10 mgd, (2) Palo Alto, 14 mgd, (3) SJ/SC, 24 mgd, and (4) Morgan Hill, 2.1 mgd.

b. Some effluent may be required for discharge, blending, or other purposes.

c. Future NPR demand for SBWR retailers, provided by SBWR staff. Does not include potential future NPR demand in Morgan Hill.

d. To improve water quality of NPR to meet a total dissolved solids (TDS) target of 500 milligrams per liter (mg/L) year-round. (Existing Silicon Valley Advanced Water Purification Center [SVAWPC] capacity is 8 mgd).

e. Assuming 90% AWPF online factor (sufficient effluent is available to meet the 24,000 AFY goal, so the facility size was capped assuming a 90% online factor).

f. 3 mgd of future flows to Renzel Marsh and potentially to horizontal levees and 0.3 mgd for losses in/around RWQCP (from 2015 Urban Water Management Plan)

g. Palo Alto and Sunnyvale AWPFs were sized to maximize production of purified water while also maintaining a reasonable AWPF efficiency, based on source flow availability. More details on flow availability and AWPF sizing are included in Appendix A-2.

h. 4 mgd for evaporation and capping at Sunnyvale's treatment ponds

mgd = million gallons per day

The evaluation shows that the SJ/SC RWF is expected to have sufficient effluent to meet Valley Water's goal of 24,000 AFY for PR. When combined, Palo Alto and Sunnyvale have the potential to yield about 23,000 AFY under the upper bound influent flows. Under the lower bound projection, Sunnyvale and Palo Alto combined has an estimated yield of 17,200 AFY for PR. This lower yield (below Valley Water's goal) is a potential risk for an AWPF dependent on effluent from Sunnyvale or Palo Alto and is considered in the portfolio comparison and analysis (Section 5). Given the limited source water available in Palo Alto and Sunnyvale, larger facilities would have higher costs with diminishing benefits. Also, the need to meet NPDES permit requirements could affect whether additional effluent needs to be reserved for blending.

In South County, the Morgan Hill satellite option would divert raw wastewater from a trunk sewer in Morgan Hill. Based on SCRWA WWTP influent flow data, the Morgan Hill trunk sewer is assumed to carry approximately 2.5 mgd of wastewater, on average. However, flow fluctuates seasonally, and in the summer months some of this flow may be needed to meet NPR demands in Gilroy. Subtracting out the wastewater needed to meet NPR demands in Gilroy, the average annual flow available for advanced treatment in Morgan Hill is approximately 2.1 mgd.

2.1.2 Delivery Point

Delivery points refer to locations where treated water would be conveyed for reuse (NPR or PR). The delivery points considered in this TM, grouped by treated water type, include:

- **NPR/NPR+**: New and existing NPR users throughout the County
- **GWR**: LGRP in North County and a combination of several percolation ponds in South County
- **SWA**: Valley Water's Anderson Reservoir in South County, near Morgan Hill
- **RWA**: South Bay Aqueduct (SBA) terminal tank at Penitencia WTP
- **TWA**: Local distribution conveyed through new pipelines to the cities of San Jose and Santa Clara (portions north of Highway 101) and through either: (a) the existing Milpitas pipeline or (b) a new pipeline to the Piedmont Valve Yard for blending with treated water near Penitencia WTP for distribution.

The following sections describe the delivery points for NPR/NPR+, GWR, SWA, RWA, and TWA.

2.1.2.1 NPR/NPR+

The four NPR producers in the County have established plans for expanding their NPR/NPR+ distribution systems, as defined in their individual recycled water master plans and summarized in Section 2.3.1.

2.1.2.2 Groundwater Recharge

LGRP is the sole North County GWR location considered in the three project portfolios. The LGRP complex is one of seven major GWR systems operated and maintained by Valley Water. Located near Los Gatos Creek, the LGRP complex is composed of six pond sets—Camden, Page, Sunnyoaks, Budd Avenue, Oka, and McGlincy—and divided into two systems, Page Ditch and Kirk Ditch. Each system has its own intra-pond conveyance system that delivers water to the individual pond sets. Page Ditch connects the Kirk Diversion Dam to the Camden, Page, Sunnyoaks, and Budd Avenue pond sets, while Kirk Ditch connects the Kirk Diversion Dam to the Oka and McGlincy pond sets.

Valley Water's *Expedited Purified Water Program Plan, Appendix E* (LGRP Facilities Plan) identified infrastructure improvements to multiple LGRP delivery points to facilitate O&M activities and maintain high recharge rates. While detailed information on these delivery points is included in the LGRP Facilities Plan, Figure 2-4 identifies pipelines to convey purified water to delivery points, including both the existing conveyance main (red line) and proposed pipelines (blue lines), as well as the four delivery points (green triangles) corresponding with the following locations:

- Budd Pond 1
- Sunnyoaks Pond 2
- Page Ditch, upstream of Page Pond 1
- Kirk Ditch near Kirk Diversion Dam

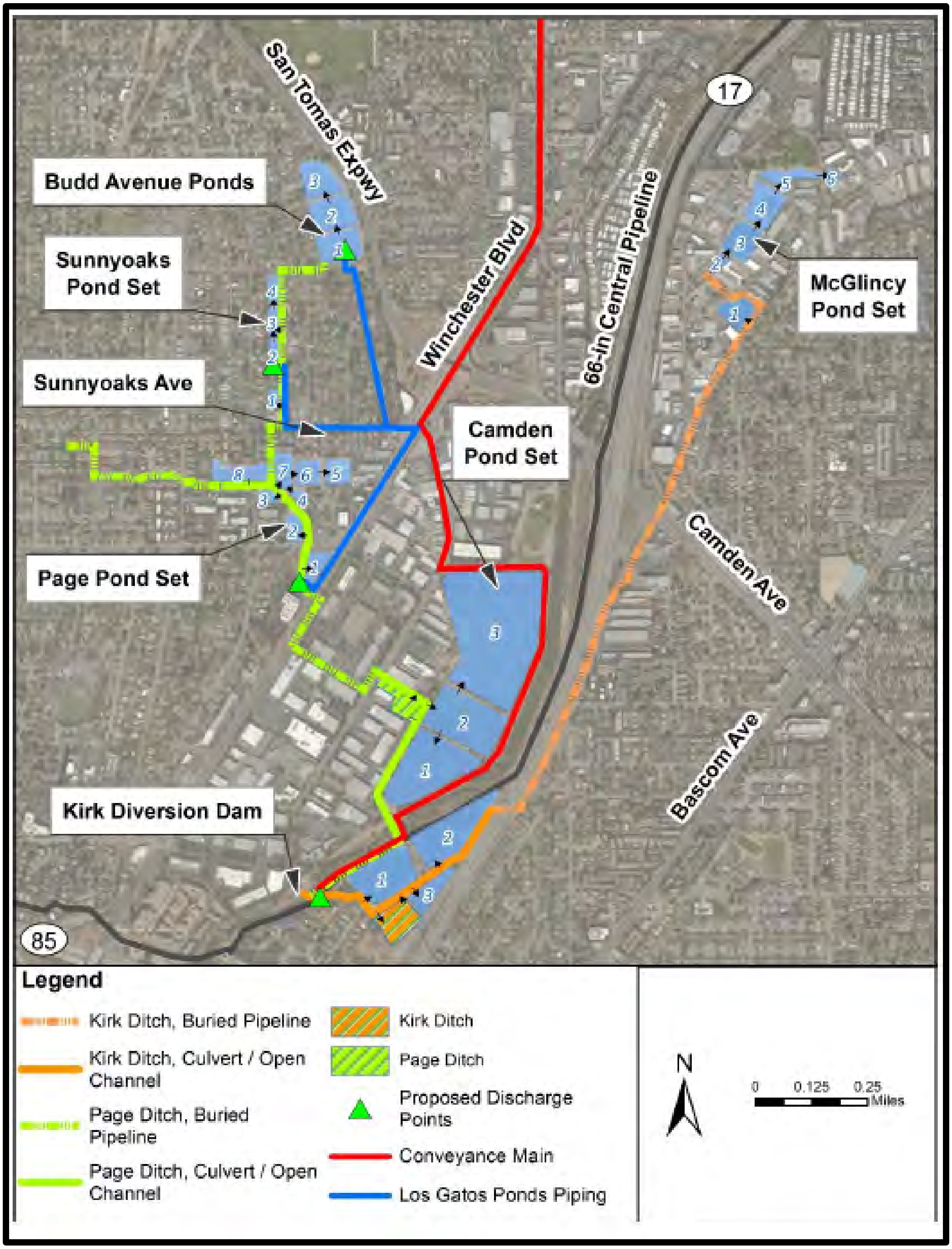


Figure 2-4. LGRP infrastructure improvements

Source: RMC/Woodard & Curran, 2017. Los Gatos Recharge Ponds Facilities Plan; Appendix E to Expedited Purified Water Program Plan.

Note: The conveyance main and LGRP piping are both proposed (future) elements.

Recharge locations in South County are more challenging. Morgan Hill relies on groundwater for potable supply, and wells are distributed throughout the area. Given the close proximity of many active potable wells to percolation ponds contemplated for GWR, the ability to achieve a minimum of two-month underground retention without impacts to wells is not feasible in the region. Any GWR project in the Llagas Subbasin would require decommissioning and possibly replacing existing wells, resulting in higher costs. Because of the challenging recharge conditions, other sites such as Main Avenue ponds or Butterfield Channel (as identified in the 2019 Sustainable Water Management Plan by the Cities of Gilroy and Morgan Hill) should be evaluated further in the event of advancing South County GWR portfolios.

2.1.2.3 Surface Water Augmentation

Incorporating SWA with the Morgan Hill GWR concept may yield water supply benefits while protecting groundwater quality of potable wells. The SWA variation involves pumping purified water from the Morgan Hill satellite facility through a new pump station and pipeline to Anderson Reservoir (Figure 2-5). With a total capacity of more than 89,000 AF, Anderson Reservoir is the largest of Valley Water’s 10 surface reservoirs. Supply from San Luis Reservoir and local runoff will substantially dilute purified water treated at a Morgan Hill satellite facility and AWPF. Consistent with current operations, Valley Water will treat the blended supply from Anderson Reservoir at Santa Teresa WTP or Rinconada WTP. (Note: Anderson Reservoir’s storage capacity is currently limited to roughly 52,000 AF due to seismic restrictions. The dam is undergoing a seismic retrofit, making the reservoir unavailable for SWA from 2020 to 2027 during construction.)

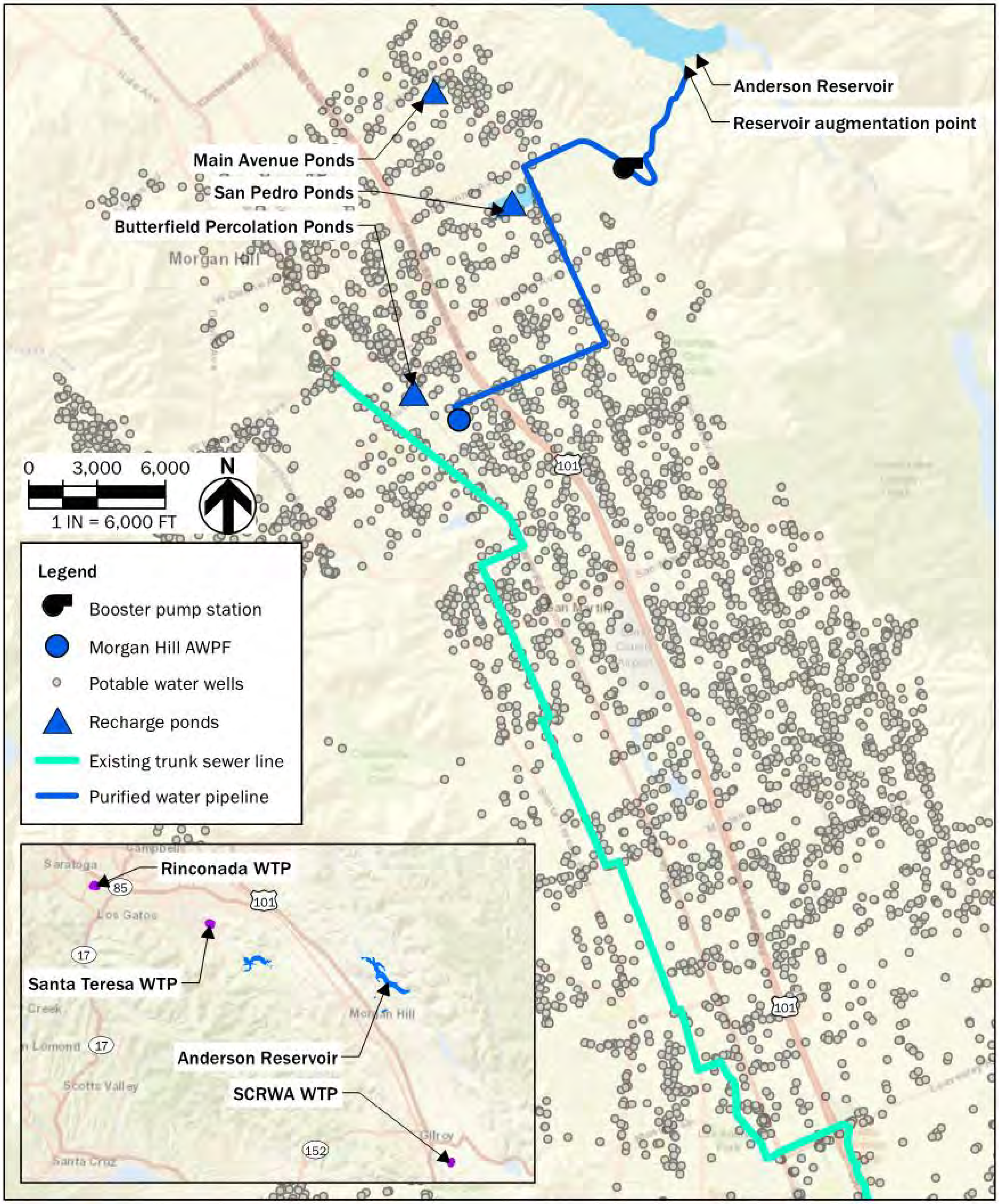


Figure 2-5. Morgan Hill recharge locations

In exchange for contributing supply to Anderson Reservoir, Valley Water would increase deliveries from the Santa Clara Conduit to existing percolation ponds to recharge Morgan Hill's groundwater basin.

2.1.2.4 Raw Water Augmentation

In the RWA scenario, purified water produced at the San José AWPF would be pumped to a proposed 3-million-gallon (MG) purified water tank sited near the Penitencia WTP—specifically, on a hill above the elevation of the existing SBA terminal tank (Figure 2-6). The 3-MG tank would provide flow rate control to introduce purified water into the existing SBA terminal tank (i.e., the blend point) as a protective measure to manage impacts of potential off-specification (off-spec) raw water. Purified water would blend with SBA flow in the existing SBA terminal tank. From this point, existing infrastructure would allow the blended water to be either treated and distributed from the Penitencia WTP or conveyed from the Penitencia Force Main (FM) to the Central Pipeline as supply to the Rinconada WTP or LGRP. The latter supports alternative delivery points when Penitencia WTP is operating near its capacity (40 mgd) and cannot treat additional supply. Routing purified water through the Central Pipeline allows access to Rinconada WTP, which has a total production capacity of 80 mgd, with planned improvements to increase capacity to 100 mgd by 2021. Figure 2-7 demonstrates monthly average production at these two WTPs. More details on the proposed delivery points for RWA can be found in Appendix C of Valley Water's *Expedited Purified Water Program Plan* (RMC/Woodard & Curran, 2018b).

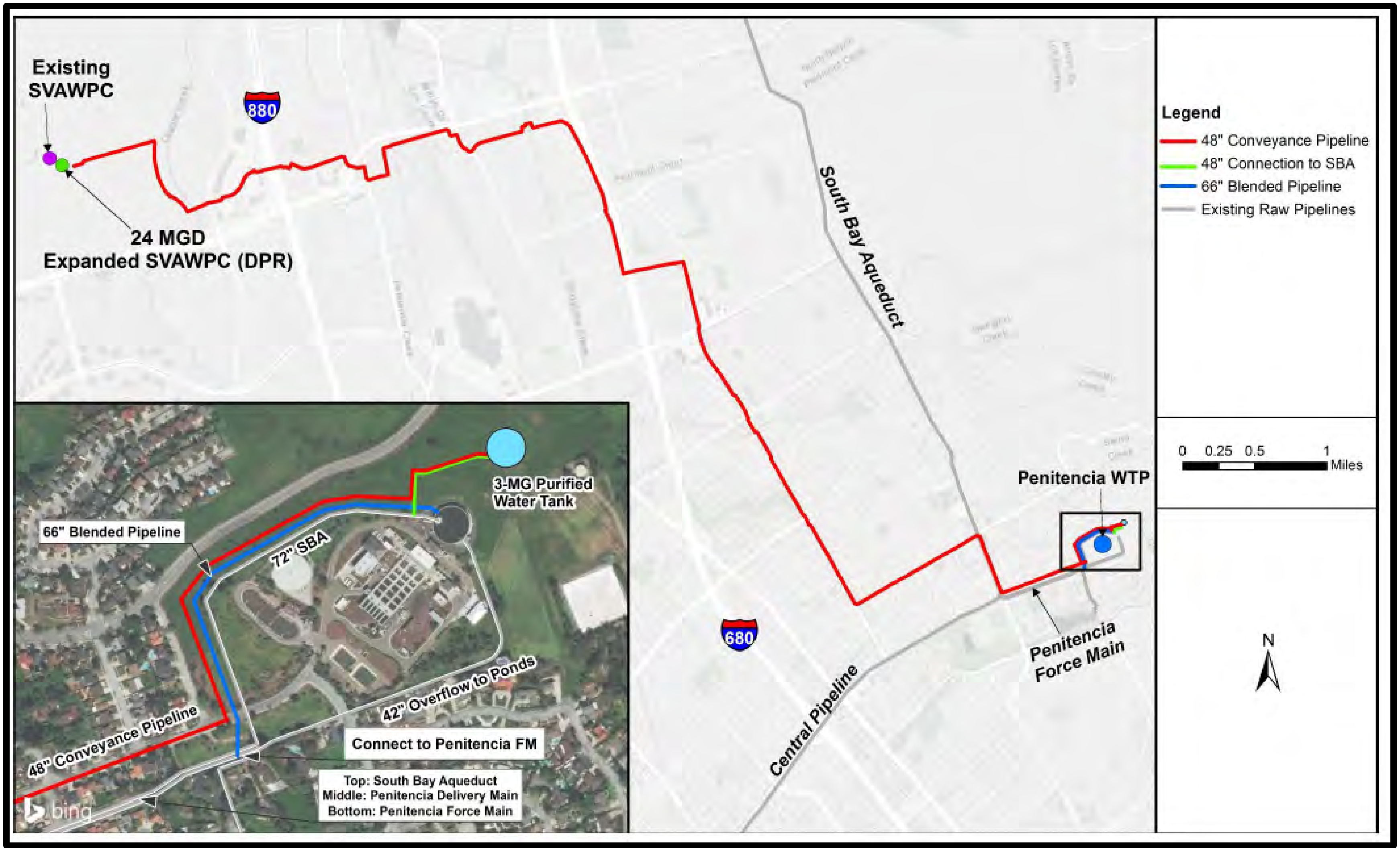


Figure 2-6. RWA delivery point facilities (Penitencia WTP) and improvements

Source: RMC/Woodard & Curran, 2018b. Direct Potable Reuse Facilities Plan; Appendix C to Expedited Purified Water Program Plan.

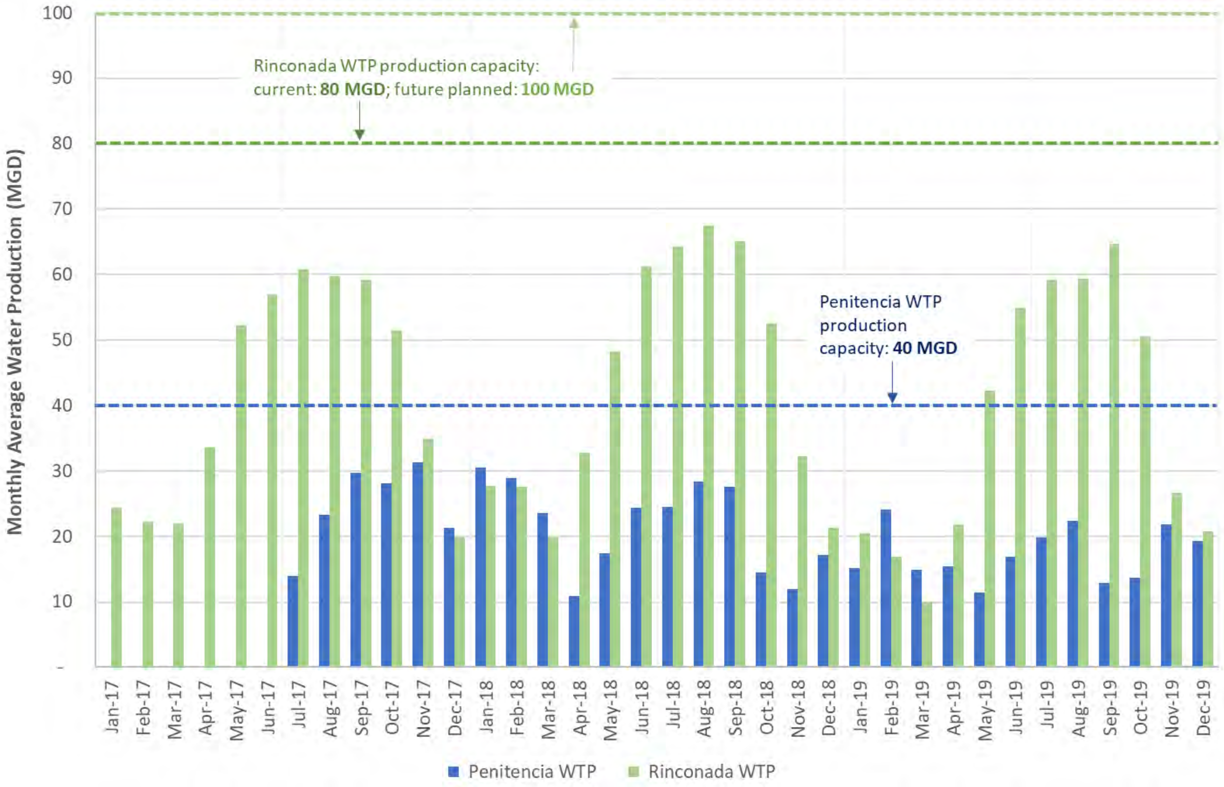


Figure 2-7. Average Monthly Production at Penitencia and Rinconada WTPs

Adding a new pipeline and pump station from LGRP to Rinconada WTP could allow purified water to flow into the upstream end of the treatment plant, creating another potential RWA scenario and increasing operational flexibility of options involving GWR. This variation would improve potable reuse supply yield when the groundwater basin is filled to capacity and recharge is not possible.

2.1.2.5 Treated Water Augmentation

The TWA concepts are structured with objectives of meeting potable water demand within Santa Clara County and/or complementing re-operation of other Valley Water supplies. The first TWA option would involve taking purified water produced at the San José AWPF and delivering directly to the cities of Santa Clara (areas both north and south of Highway 101) and San José (north of Highway 101), San Jose Water, and other Valley Water users by conveying purified water through the Milpitas pipeline. Turnouts would be located near existing storage tanks, transmission mains, or other feasible locations. The other TWA scenario would also include distribution to Santa Clara and San José (north of Highway 101) and San Jose Water, but not to users along the Milpitas pipeline, and instead would pump the purified water to the existing Piedmont Valve Yard near the Penitencia WTP. The purified water would be blended with treated water from the Penitencia WTP before distribution. These TWA concepts are discussed further in Section 3.3.

2.1.3 Treatment Processes

Reuse treatment requirements are a function of source water quality, existing WWTP processes, intended use of product water, regulatory requirements, and local/regional requirements and setting. Table 2-4 summarizes general descriptions of the various treatment unit processes used by AWPFs, their primary treatment objectives, and key process variables for monitoring compliance and performance verification.

Table 2-4. Various Treatment Processes used by AWPFs

Treatment Process	General Description	Role in AWPF Treatment Process	Process Considerations
Membrane filtration	Membrane filtration refers to low-pressure membrane processes including MF/UF. MF and UF operate primarily by size exclusion; UF membranes have an effective pore size of about 0.01 micrometers (µm), while MF membranes' effective pore size is about 0.1 µm.	Membrane filtration removes particles larger than the membrane's effective pore size, including *Giardia* and *Cryptosporidium*, but is relatively ineffective at removing viruses, organic compounds, or salinity.	Membrane filtration is typically considered a pretreatment process that protects downstream RO performance and integrity by removing particulates that may damage the RO membranes. Pathogen log removal and membrane integrity can be verified using continuous turbidity measurements and daily pressure decay tests (PDT). Log removal credit is generally limited by the PDT resolution such that credits for 4-log removal of *Cryptosporidium* and *Giardia* can be acquired.
RO	RO involves pushing water at high pressure through a partially permeable membrane and thereby removing dissolved organic compounds and ions from the water, including most CECs.	RO is used to remove pathogens and many chemical constituents. When the integrity of the RO membrane is sound, it is understood to remove essentially all pathogens from the permeate. (Note: Unlike MF/UF membranes, RO does not have an integrity test.) While most chemical constituents are removed by RO, it is less effective at removing uncharged, polar low-molecular weight compounds, particularly several classes of disinfection byproducts (DBP) like halogenated compounds and aldehydes and ketones[a].	As discussed previously, RO creates a residual stream (concentrate) that is typically 10 to 20 percent of the feed stream volume and creates challenges for inland disposal. Parameters used for monitoring RO performance include conductivity and total organic carbon (TOC) (often using on-line TOC analyzers). TOC removal is often used to approximate pathogen removal but regulations limit LRV credit to 2-logs for V/G/C when monitoring using TOC. Technologies such as the Trasar™ additive may be used to demonstrate greater microbial log removal credits. The use of such markers could allow for 3-logs or more credit each for V/G/C.
Ultraviolet/ advanced oxidation process (UV/AOP)	UV/AOP uses very high-intensity UV light combined with an oxidant such as chlorine, ozone, or hydrogen peroxide to provide advanced disinfection as a final polishing step following RO. Hydrogen peroxide is used as the oxidant in this analysis. The UV doses used for UV/AOP are significantly greater than the dose required in most drinking water applications. A typical dose for UV/AOP is 800-900 millijoules per square centimeter (mJ/cm^2), but only 100 mJ/cm^2 for disinfected tertiary recycled water and around 40 mJ/cm^2 for typical drinking water applications.	UV is highly effective for disinfection, providing up to 6-log inactivation of V/G/C.	The key parameters for verifying UV/AOP system performance are UV intensity, flow rate, UV transmittance (UVT) at 254 nanometers (nm), and chemical dosing rate. RO permeate typically has a UVT between 97 and 99 percent.
Product water stabilization: Decarbonation/air stripping and lime addition	Decarbonation/ air stripping reduces dissolved carbon dioxide, which helps minimize the quantity of lime or caustic necessary to reach a target stable pH, specific to the water quality goals of the delivery point. The decarbonators/air strippers also help reduce water temperature to address aesthetics concerns and provide an additional mechanism of chemical control (volatilization) to complement other barriers. Lime addition increases the pH, alkalinity, and calcium concentration in the water and acts to stabilize the water and minimize corrosivity.	The RO permeate that feeds into the UV/AOP is highly corrosive and can corrode conveyance pipelines, depending on pipe material. Decarbonation is combined with lime addition to accomplish product water stabilization.	As currently configured, decarbonation/air stripping is located upstream of the AOP since it is being assumed that the UV system will be using hydrogen peroxide to be consistent with previous studies and the existing SVAWPC system. In many designs, decarbonation/air stripping is either located downstream of UV/AOP or not included, depending on unconditioned treated water quality and final water quality goals. Relocation of decarbonation/air stripping downstream of the UV/AOP to allow for flexibility in UV/AOP oxidant selection and optimize water stabilization is recommended for consideration. Only a portion of the product water will be decarbonated/air stripped and then blended with remaining product water. The amount of lime needed, as well as the entire post-treatment strategy, is determined using various corrosivity indices, such as the Langelier Saturation Index or Aggressiveness Index, and would be informed by corrosion control studies. Sodium hypochlorite would also be added to the product water to help neutralize the remaining hydrogen peroxide from the AOP and provide free chlorine residual to prevent microbial growth in the conveyance pipeline.
Chlorine disinfection	Chlorine disinfection provides additional protection against microbes and viruses, as well as a residual for distribution. It is used to provide additional LRV credits for RWA and TWA. Dose and contact time may be based on EPA guidance for disinfection of drinking water.	Both RWA and TWA do not benefit from LRV credits that GWR gains from retention in a groundwater aquifer, and free chlorine disinfection can achieve additional LRV credits for viruses and *Giardia*. It is ineffective for *Cryptosporidium*. Chlorine can also provide residual disinfectant to prevent biofilm growth in the distribution system.	For TWA, purified water would be routed through chlorine contact basins that would provide sufficient detention time for disinfection to occur; additionally an 8-hour clearwell provides emergency storage in the event of process interruptions. Free chorine disinfection would be implemented in the pipeline between the AWPF and Penitencia WTP for both RWA and TWA.
O_3- BAC	The O_3 process is a chemical oxidation and disinfection process that (1) oxidizes organic matter for ready biodegradation by microorganisms in the BAC and (2) provides targeted LRV credits required for the project. BAC is a biological process that metabolizes the organic matter in the O_3 effluent to increase the removal of bulk organics (TOC) and further reduces the concentration of CECs.	In the proposed RWA treatment train, O_3 and BAC is a combined pre-treatment process that removes organic matter and CECs, including trace organics such as N-nitrosodimethylamine (NDMA). The O_3-BAC process helps address two of the priority topics for DPR in California—control of chemical peaks and low-molecular weight compounds, e.g., certain DBPs. O_3-BAC treatment is also expected to reduce CECs in ROC.	BAC is typically designed with granular activated carbon (GAC) media because GAC has a larger surface area to attract microorganisms to the particle surfaces. BAC does not provide pathogen reduction or reduce salinity. A contact vessel provides the necessary residence time for reaction, and O_3 residuals are monitored at multiple points along the contactor vessel. Each residual monitoring point can be used for performance verification. Performance can also be monitored via TOC analyzers on the filtrate.

a. *Marron, et al. (2019)*

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2.1.3.1 NPR and NPR+

The four WWTPs in the County include recycled water production facilities that meet Title 22 disinfected tertiary recycled water requirements. At the SJ/SC RWF, Valley Water's SVAWPC also provides purified water to reduce salinity of SBWR's NPR supply. A similar facility is planned at the Palo Alto RWQCP and will include MF/UF and RO facilities as identified in the City of Palo Alto's 2017 *Advanced Water Purification System Feasibility Study - Final*. Figure 2-8 shows the process flow diagram for the proposed Palo Alto facility.

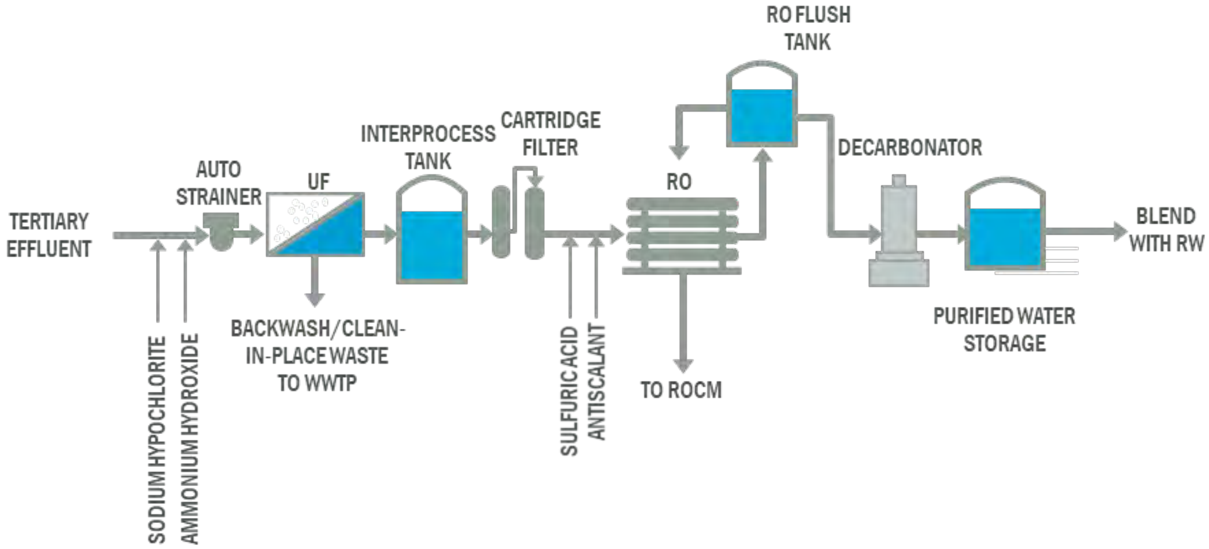

Figure 2-8. Palo Alto NPR+ process flow diagram

Source: Palo Alto, Mountain View, and Valley Water (2017)

If NPR systems in North County were connected through interties, Sunnyvale may also consider an AWPF to provide water quality consistent with SBWR and PA/MV systems. This facility would include MF/UF, RO, disinfection, and associated ancillary facilities to support production of NPR+.

For the SBWR service area, NPR+ distribution system expansion is planned, and new requests for recycled water will increase demand on the system. To continue serving blended water quality with salinity under 500 mg/L during peak months, the existing SVAWPC may need to be expanded or a new facility would need to be constructed. If water quality can vary over the course of the year with an average salinity of 500 mg/L, then a smaller capacity increase would be needed, if any at all. Figure 2-9 shows the process flow diagram for the proposed San José facility that would match the existing SVAWPC and expand NPR+ supply.

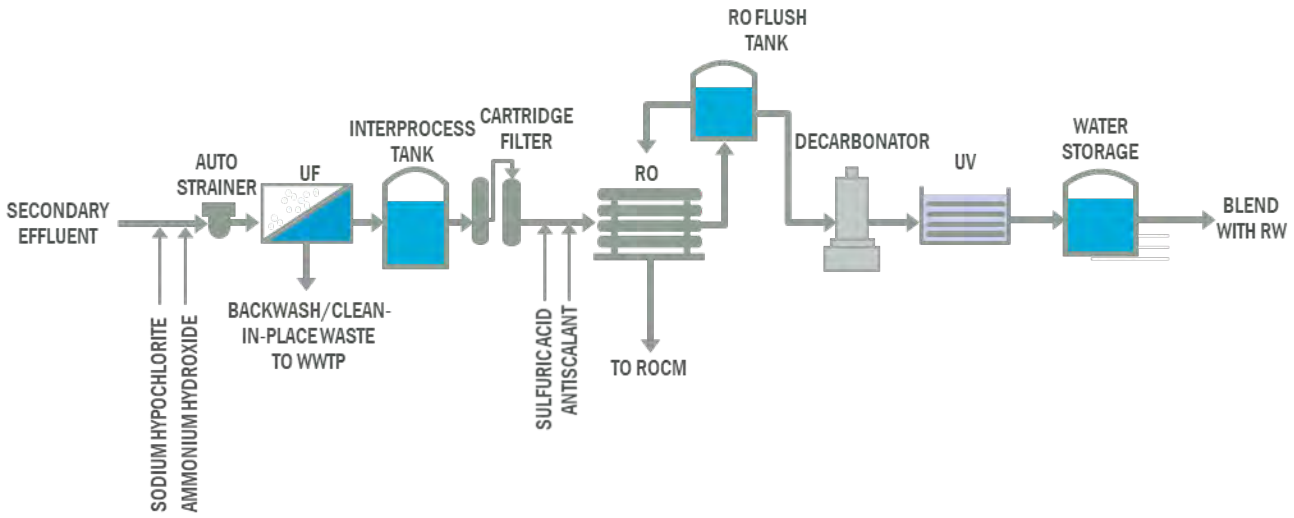

Figure 2-9. NPR+ process flow diagram for San José AWPF (based on SVAWPC)

Table 2-5 summarizes the estimated costs for NPR+ facilities.

Table 2-5. Estimated Costs for NPR+ AWPF

Element	Palo Alto NPR+[b] ($2019, in millions)	Sunnyvale NPR+[c] ($2019, in millions)	SBWR NPR+[d] ($2019, in millions)
Total Capital Cost	$21	$18	$83
O&M Costs	$1.0	$0.5	$2.8
Projected NPR Demand (2040)[a]	2.5 mgd	1.5 mgd	27.6 mgd

a. *Palo Alto and Sunnyvale NPR demand projections from 2015 UWMP; SBWR retailers' projections updated based on input from SBWR staff.*

b. *Based on estimated cost for 2.25-mgd facility in Advanced Water Purification System Preliminary/Conceptual Design Report, December 2017. Estimated cost escalated to August 2019 value, as described in Attachment C.*

c. *The estimated cost for the Sunnyvale 1.2-mgd facility was scaled from the Palo Alto Facilities estimated cost.*

d. *The estimated cost for an additional 8-mgd facility SJ/SC NPR+ facility was based on the existing SVAWPC construction cost and escalated to August 2019 value. Implementation cost factors, as provided in Appendix A-5 - Basis of Cost, were applied to the estimated construction cost to develop a total capital cost.*

2.1.3.2 Groundwater Recharge

Though FAT provides a higher level of treatment than the minimum required by regulations for GWR via surface spreading, Valley Water selected FAT as the preferred treatment train for GWR to protect groundwater quality and limit salt and nutrient loading. A FAT process train composed of membrane filtration, RO treatment, and UV/AOP also allows for GWR via injection wells—an option previously identified in the Expedited Purified Water Program Plan. Furthermore, FAT can reduce TOC concentrations to levels that allow GWR without a need for dilution water.

Treatment goals and default pathogen reduction credits granted for each FAT unit process are summarized in Table 2-6. LRV requirements (12/10/10 log reduction of V/G/C) are dictated by Title 22, Article 5.1 (IPR: Groundwater Replenishment, Surface Application). California's approach assumes log removal credits are met starting from untreated wastewater. State regulations only allow up to 6-log removal of any pathogen per unit process, excluding underground retention. A FAT process train demonstrates at least 1-log removal of each pathogen with three different barriers.

Table 2-6. GWR FAT-Based Advanced Treatment Performance

	Microbiological log removal credits			Organic matter removal		
Unit processes	Viruses	*Giardia*	*Cryptosporidium*	Dissolved TOC	CECs[a]	Salinity
Default credits						
Secondary Effluent	0.4	0.2	0	Yes	Yes	No
UF	0	4	4	No	No	No
RO	1.5	1.5	1.5	Yes	Yes	Yes
UV/AOP	6	6	6	No	Yes	No
Underground retention / soil aquifer treatment	6[b]	10[c]	10[c]	Yes	Yes	No
Total	13.9	21.7	21.5	--	--	--
Required credits						
Required	12	10	10	Yes	Yes[d]	No[e]
Balance	1.9	11.7	11.5	--	--	--

a. *Each unit process targets certain CECs, but not all CECs will be removed.*

b. *A 1-log credit is granted for each month of underground retention time demonstrated with an added tracer. This credit drops to 0.5-log per month when underground retention time is demonstrated with a numerical model. For subsurface application, for each month retained underground, recharge water credited with 1-log virus reduction per CCR, Title 22, Division 4, Chapter 3, Article 5.2, Section 60320.208 (groundwater replenishment–subsurface application). Groundwater modeling results show purified water introduced at LGRP is retained for at least one year before reaching potable supply wells.*

c. *A 10-log credit is granted for Giardia and Cryptosporidium for surface spreading when 6 months underground retention time is demonstrated with a tracer study. This credit drops to 0-logs if the AWPF is used for injection.*

d. *Not all CECs require specific removal rates. The requirements can vary based on known or perceived human health risk and are informed by site-specific water quality monitoring and current and proposed regulations. Typical removal rates range from 70% to more than 99%, depending on the unit processes.*

e. *Managing salinity is a long-term sustainability issue that must be considered in the treatment process selection. Not every system will require salinity removal.*

Potential GWR project elements in North County involve source water from Palo Alto RWQCP, Sunnyvale WPCP, and/or SJ/SC RWF for purified water production and conveyance to LGRP. The South County GWR option would involve diverting Morgan Hill's liquid stream to a satellite facility for treatment, along with an AWPF. Estimated AWPF costs assumed an online factor of 90 percent to account for equipment downtime for maintenance and improvements. The factor increases the overall production capacity of the AWPF with the intent of reaching the production target of 24,000 AFY.

While facility layouts and designs are often driven by agency perspectives and culture, the existing SVAWPC was used to inform the proposed AWPF layouts. Key aspects of the existing SVAWPC include locating major equipment for the UF, RO, and UV/AOP systems within a process building to provide protection from the weather. For site planning, representative equipment layouts were arranged within the building to allow for efficient O&M access. The process building also includes space for staff and facilities to support operation and maintenance of the AWPF. Ancillary facilities, chemical storage, water storage, and pumping facilities are assumed to be outside or under canopies.

North County AWPFs used for GWR share a similar process flow diagram, shown in Figure 2-10.

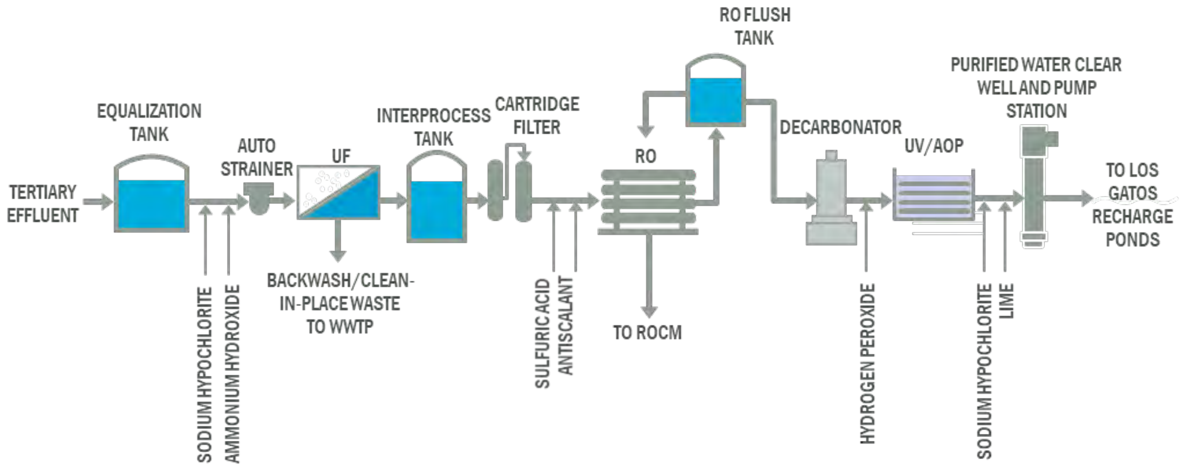

Figure 2-10. AWPF process flow diagram for GWR

The Morgan Hill satellite facility would require wastewater treatment facilities in addition to AWPF facilities to meet regulatory requirements. The envisioned treatment process is to use an MBR process followed by RO and UV/AOP (Figure 2-11). MBR was selected as the treatment choice for Morgan Hill because a facility for treating wastewater to secondary effluent quality does not currently exist. An MBR can be used to provide both biological nutrient removal, organic matter removal, and particulate filtration for the subsequent RO process at a lower cost than individual activated sludge and membrane filtration. In addition, MBR is an effective process for sites with relatively small footprints and limited flow variation, like Morgan Hill. MBR has not yet been granted LRV credit in California, but several projects are planning on using the Australian Tier 1 approach for LRV credit, and the Tier 1 LRV values are assumed in these concepts for planning purposes.

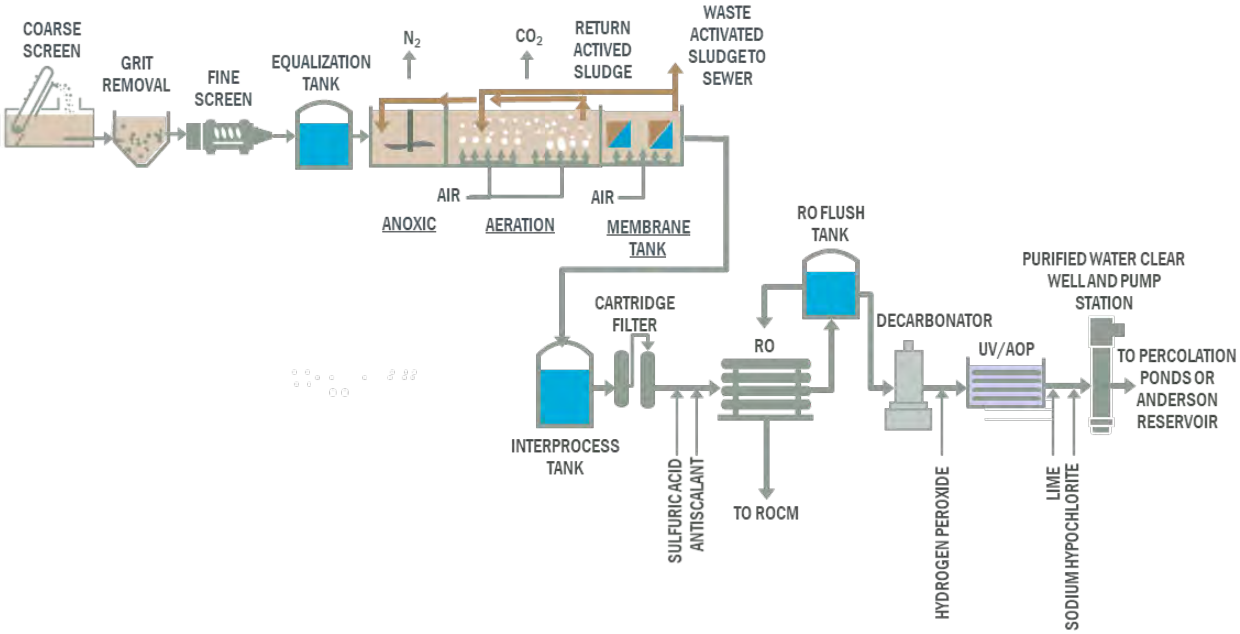

Figure 2-11. Morgan Hill satellite treatment facility process flow diagram

To meet the California regulations of 12/10/10 for V/G/C, advanced monitoring equipment for RO, such as dye monitoring or TRASAR technology, would be added to confirm LRV performance and credit. Furthermore, disinfection with free chlorine could be added to achieve additional credits for virus and *Giardia*. Table 2-7 summarizes the LRVs for each process to meet GWR requirements. As MBR does not provide significant removal of CECs, salinity, and dissolved organic carbon, only LRV credits are summarized in Table 2-7.

Table 2-7. Log Removal Credits for Morgan Hill Satellite Facility and AWPF

Unit process	Log removal credits		
	Virus	*Giardia*	*Cryptosporidium*
MBR[a]	1.5	2	2
RO[b]	3	3	3
UV/AOP	6	6	6
Underground retention[c]	2	0	0
Total	12.5[d]	11[d]	11

a. MBR LRV credits based on the Australian Tier 1 approach.

b. RO process assumes advanced monitoring would support LRV credit of 3-3-3 for V/G/C.

c. Virus removal of 1-log is granted for each month of travel time in the groundwater basin.

d. Free chlorine disinfection can be added to increase LRV credits for virus and Giardia.

For the SWA approach using Anderson Reservoir as a delivery point from the Morgan Hill satellite facility, at least one additional process would be needed to meet required log removal for viruses, as there is no credit for underground retention as in GWR. Free chlorine disinfection could be implemented, which can provide up to 6 LRVs for virus with a CT of 2 mg/L-min (Pecson et. al, 2017), as well as ozone-biologically active carbon.

2.1.3.3 Raw Water Augmentation

The Expedited Purified Water Program Plan evaluated a potential RWA project that would blend purified water and SBA raw water to supply the Penitencia and Rinconada WTPs. Based on DDW's current position on DPR, a treatment train to meet anticipated regulatory requirements is likely to require FAT as a minimum baseline level of treatment, and additional treatment elements will likely be needed to comply with stricter requirements for both pathogen and chemical control. A FAT process train with the addition of O_3-BAC pretreatment and free chlorine disinfection would likely be capable of satisfying the minimum requirement for RWA facilities.

While DDW has not yet established pathogen requirements for RWA, an initial assessment of processes for the RWA treatment train were selected considering both pathogen and chemical treatment. (Refer to Table 2-4 for a general description of each unit process, its role in the RWA AWPF train, and key process variables for monitoring performance.) Table 2-8 provides default credits and demonstrates the level of pathogen treatment applicable to each treatment process. Virus and *Giardia* are expected to have high LRV, well in excess of IPR requirements and likely in compliance with future RWA regulations. *Cryptosporidium* LRV also exceeds the IPR requirements. LRV redundancy will be beneficial for operating AWPFs and maintaining a high degree of system availability (i.e., online reliability). This benefit supports the strategy of seeking additional credits, which may be most cost-effectively accomplished by seeking higher credits for existing processes. Some processes may be credited with higher LRV (e.g., through treatment studies or different monitoring approach) within the future RWA regulations.

Table 2-8. RWA FAT-Based Advanced Treatment Performance

	Microbiological log removal credits			Organic matter removal				
Unit Processes	Viruses	*Giardia*	*Crypto-sporidium*	Dissolved TOC	CECs[a]	Chemical peaks	Low-molecular-weight compounds	Salinity[b]
Default credits								
Tertiary effluent SJ/SC RWF	0.4[c]	0.2[c]	0[c]	Yes	Yes	--	--	No
O_3/BAC	6	6	1	Yes	Yes	Yes	Some	--
UF	0	4	4	No	No	No	No	No
RO	2	2	2	Yes	Yes	Yes	Some[d]	Yes
UV/AOP	6	6	6	No	Yes[e]	Yes[e]	Some[e]	No
Air stripping	0	0	0	No	No	Some[h]	No	No
Free chlorine disinfection	6	1	0	No	No	No	No	No
RWF and AWPF total	20.4	19.2	13	--	--	--	--	--
WTP credits[f]	4	3	2	No	No	No	No	No
Total	24.4	22.2	15	--	--	--	--	--
Required credits								
Required	TBD	TBD	TBD	Yes	Yes[g]	Yes	Yes	No[b]

a. *Each unit process targets certain CECs, but not all CECs will be removed.*

b. *Managing salinity is a long-term sustainability issue that must be considered in the treatment process selection. Not every system will require salinity removal.*

c. *Default credit expected for secondary treatment extrapolated from Rose (2004) study*

d. *RO is typically less effective for control of low molecular-weight organic compounds that are uncharged and polar (e.g., acetone). Rodriguez, C et al. (2009)*

e. *UV/AOP will provide some treatment for chemical peaks of constituents amenable to treatment by the process (e.g., 1,4-dioxane)*

f. *Current regulations for SWA allow for some pathogen removal credits from the surface WTPs. It is assumed that RWA could be granted the same credits; however, the current understanding of the future RWA regulations suggest that the credits will have to be demonstrated with monitoring, similar to crediting for PR facilities.*

g. *Not all CECs require specific removal rates. The requirements can vary based on known or perceived human health risk and are informed by site-specific water quality monitoring and current and proposed regulations. Typical removal rates range from 70% to more than 99%, depending on the unit processes.*

h. *Air stripping, which can be accomplished with air strippers or decarbonators, provides another barrier for chemical control, such as removal of volatile organic compounds*

Treatment will only be one of the requirements for RWA. Compared to IPR, DPR requirements will be more stringent for source control, wastewater treatment, response time, monitoring, and failure response (i.e., diversions, alternate supply, operator training). The Master Plan will provide more detail on these topics.

The proposed 24-mgd RWA AWPF would be constructed adjacent to the existing SVAWPC and treat tertiary effluent from the SJ/SC RWF to produce purified water. The AWPF would be located on the approximate 17.8-acre parcel immediately adjacent to the existing SVAWPC. Figure 2-12 depicts the process flow diagram for this facility.

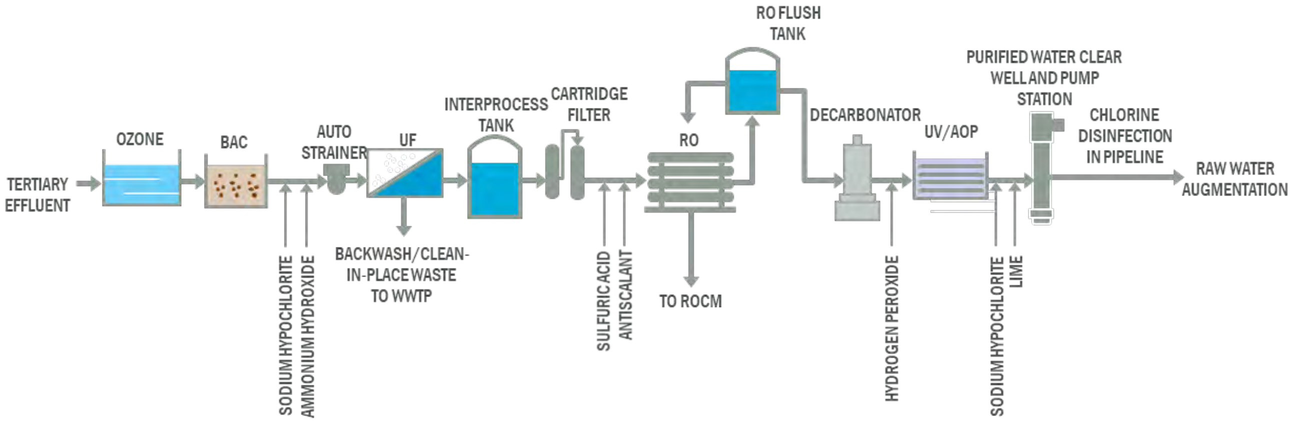

Figure 2-12. AWPF process flow diagram for RWA

Beyond the preliminary design criteria summarized in Attachment A for the 24-mgd AWPF for RWA, the Expedited Purified Water Program DPR Facilities Plan provides a more in-depth description of design details.

2.1.3.4 Treated Water Augmentation

As mentioned previously, the DDW released a proposed framework for regulating DPR in 2018 and a second edition of the framework in August 2019. The framework provides a common structure to help assess and manage risks associated with DPR, identifies key factors and approaches to protect public health across various forms of DPR (i.e., TWA and RWA), and establishes a timeline to develop DPR regulations by December 31, 2023, with provisions for extending the deadline. While the initial framework focused on a phased approach to developing DPR regulations starting with RWA regulations, DDW revised the approach and, as reflected in the second edition, anticipates developing a single DPR regulation package inclusive of both RWA and TWA by December 2023. The potential for TWA regulations to be established by December 2023 represents a changed condition for developing potable reuse opportunities in the Master Plan and allows for TWA opportunities to be considered in this effort.

In the absence of established regulations, TWA concepts were developed based on assumptions that draw on existing potable reuse regulations, the second edition framework, and current industry best practices. Based on DDW's current position on DPR, FAT is anticipated to be the minimum baseline, and additional treatment elements will likely be needed to comply with stricter requirements for pathogen and chemical control. A FAT process train with the addition of O_3-BAC pretreatment and chlorine disinfection was assumed to be the minimum requirement for TWA facilities.

With ample pathogen reduction in the treatment processes for RWA, the TWA treatment train focuses on additional chemical control and/or chemical peak attenuation, post-treatment stabilization, temperature, and barriers to allow appropriate response time. While secondary treated effluent is currently successfully treated at SVAWPC, Valley Water proposes to require tertiary level of treatment for effluent in TWA projects as an added safeguard to further protect public health and to improve AWPF treatment effectiveness/ redundancy. In lieu of additional log reduction value LRV requirements, this treatment train considers the potential to demonstrate higher LRVs for the upstream WWTP(s) or RO (Table 2-9), if needed.

Table 2-9. TWA FAT-Based Advanced Treatment Performance

Unit processes	Microbiological log removal credits			Control of chemical compounds				Salinity[b]
	Viruses	*Giardia*	*Crypto-sporidium*	TOC	CECs[a]	Chemical peaks	Low molecular-weight compounds	
Default credits								
Tertiary WW treatment	0.5[c]	0.5[c]	0.5[c]	Yes	Yes	--	--	No
Ozone/BAC	6	6	1	Yes	Yes	Yes	Yes	No
UF	0	4	4	No	No	No	No	No
RO	2.5[d]	2.5[d]	2.5[d]	Yes	Yes	Yes	Some[e]	Yes
UV/AOP	6	6	6	No	Yes[f]	Yes[f]	Yes[f]	No
Cooling tower/air stripper	--	--	--	No	Yes	Yes	Yes	No
Chlorine disinfection	6	1	0	No	No	No	No	No
Total	21	20	14	--	--	--	--	--
Required credits								
Required	TBD	TBD	TBD	Yes	Yes[a]	Yes	Yes	No[b]

a. *Not all CECs require specific removal rates. The requirements can vary based on known or perceived human health risk. Typical removal rates range from >70% to over 99%.*

b. *Managing salinity is a long-term sustainability issue that must be considered in the treatment process selection. Not every system will require salinity removal.*

c. *Conservative estimate for pathogen LRVs stemming from site-specific pathogen monitoring study.*

d. *Assumes facility uses enhanced RO monitoring (such as TRASAR) for additional RO crediting.*

e. *RO is typically less effective for control of low molecular weight organic compounds that are uncharged and polar.*

f. *UV/AOP will provide some treatment for chemical peaks of constituents amenable to treatment by the process (e.g. 1,4-dioxane).*

The proposed 24-mgd TWA AWPF would be constructed adjacent to the existing SVAWPC and treat tertiary effluent from the SJ/SC RWF to produce purified water. Treatment processes were selected considering both pathogen and chemical treatment in terms of microbiological log removal, control of chemical compounds, and salinity reduction and structured as a proposed TWA treatment train (Figure 2-13). Future DPR regulations are assumed to include additional requirements to address two topics of concern for chemical control: (a) attenuation of chemical peaks (i.e., high concentrations of chemicals that may be released into the treatment process, as from an industrial spill), including both known and unknown compounds; and (b) increased removal of low molecular weight compounds, including both known and unknown compounds that have been observed to pass through FAT trains. The selected TWA treatment train is believed adequate to address these two DPR chemical control issues. Both the potential future regulatory requirements and justification for the proposed TWA treatment train will be described in D9 – Draft Countywide Water Reuse Master Plan.

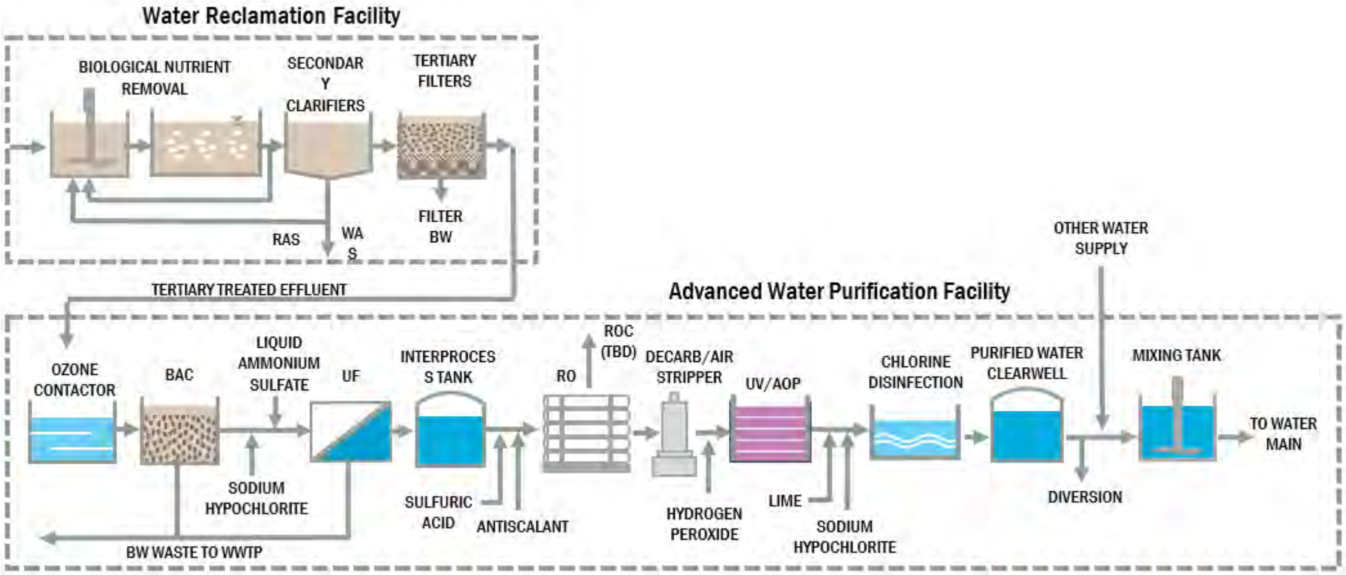

Figure 2-13. AWPF process flow diagram for TWA

2.2 Residuals Management

Each potential AWPF is anticipated to consist of a process train that includes RO membrane filtration and UV/AOP. MF/UF pretreatment is anticipated for AWPFs in North County, and backwash water from the MF/UF treatment is expected to be returned to the head of the respective WWTP. In South County options, MBR residuals from the Morgan Hill satellite facility may be discharged to SCRWA, although this would require further study and a future agreement. Issues related to residuals management in South County are discussed in Section 3.5.

ROC management strategies will vary depending on AWPF location and capacity. Various management options are being considered as part of Valley Water's ROCMP developed in parallel with the Master Plan and included in Attachment F. The ROCMP team is informing the feasible portfolios evaluation, specifically in terms of site-specific ROC management options, costs, and permitting complexity.

Table 2-10 presents the primary ROC management strategy recommended for each proposed AWPF, as reflected in Valley Water's most recently available ROCMP TMs (Attachment F). For locations where more than one ROC management strategy is identified, Option 1 is reflected in AWPF capital costs in Sections 3 and 4 of this TM.

Table 2-10. ROC Management Recommendations from ROCMP team

AWPF location	Option 1 description	Option 2 description	Option 3 description
San José Regional AWPF	Blend ROC with residual final effluent downstream of the compliance point for the SJ/SC RWF (i.e. after the weir).	Discharge ROC to a new shallow outfall at a point in Coyote Creek that has been shown by hydrodynamic modeling to provide enhanced mixing.	N/A
Combined Regional AWPF in Palo Alto	Blend and discharge ROC to the existing outfall from the Palo Alto RWQCP.	Discharge ROC to a new outfall at a point in SF Bay that has been shown to provide enhanced mixing.	Discharge the ROC to an existing deep-water outfall located in Redwood City and discharges past the Dumbarton Bridge.
Combined Regional AWPF in Sunnyvale	Discharge ROC to a new shallow outfall at a point in Guadalupe Slough that has been shown to provide enhanced mixing.	N/A	N/A
Separate AWPFs in Palo Alto and Sunnyvale	At Palo Alto, blend and discharge ROC to the existing outfall from the Palo Alto RWQCP. At Sunnyvale, discharge ROC to a new shallow outfall at a point in Guadalupe Slough that has been shown to provide enhanced mixing.	At Palo Alto, discharge ROC to a new outfall at a point in SF Bay that has been shown to provide enhanced mixing. At Sunnyvale, discharge ROC to a new shallow outfall at a point in Guadalupe Slough that has been shown to provide enhanced mixing.	At Palo Alto, discharge the ROC to a deep-water outfall north of the Dumbarton Bridge. At Sunnyvale, discharge the ROC to a new shallow outfall at a point in Guadalupe Slough that has been shown to provide enhanced mixing.
AWPF in Morgan Hill	Morgan Hill AWPF ROC would be piped to an evaporation pond located on SCRWA property in Gilroy.	N/A	N/A

Other management options were considered but determined to be infeasible based on the ROCMP team's evaluation. For example, deep well injection is infeasible based on Valley Water's policy for aggressively protecting the groundwater basin. In addition, full-scale implementation of treatment was eliminated after a pilot study did not show effective removal of chelated metals or selenium from ROC. Treatment for nutrients, chronic toxicity, and CECs may be possible but requires further study.

The ROCMP team selected management options based on an assessment of water quality impacts to the SF Bay and an individual facility's ability to meet NPDES permit requirements. The ROCMP team conducted mass balance dilution modeling to evaluate water quality impacts of ROC discharge at the various outfall locations. Presented in the following subsections are recommended ROC management options for each AWPF with descriptions of NPDES permitting issues, contaminants that affect each location, and costs associated with the ROC management options. Figure 2-14 shows the locations of pipelines proposed by the ROCMP team for recommended ROC management strategies.

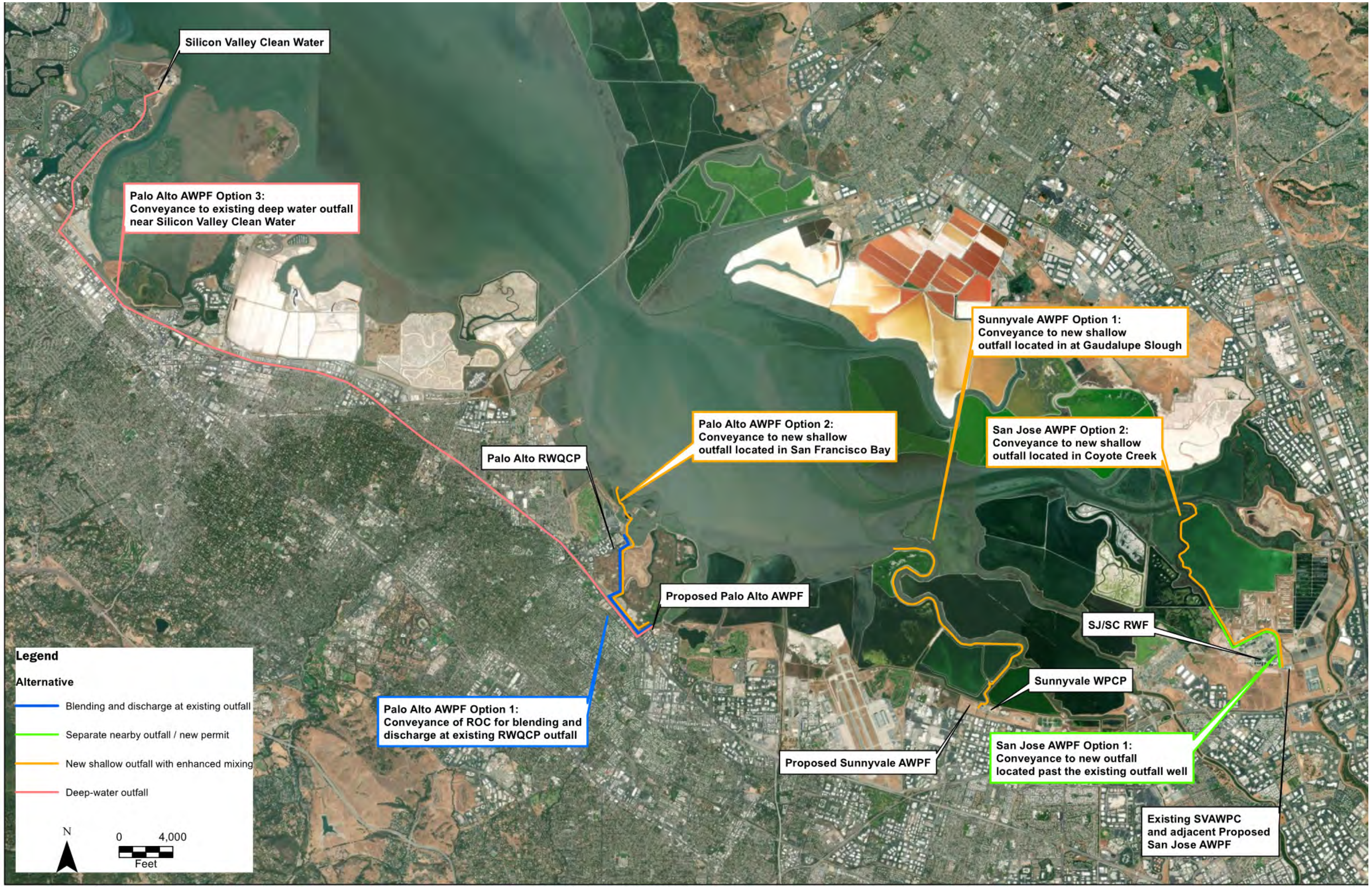
Silicon Valley Clean Water
Palo Alto AWPF Option 3: Conveyance to existing deep water outfall near Silicon Valley Clean Water
Sunnyvale AWPF Option 1: Conveyance to new shallow outfall located in at Gaudalupe Slough
Palo Alto AWPF Option 2: Conveyance to new shallow outfall located in San Francisco Bay
San Jose AWPF Option 2: Conveyance to new shallow outfall located in Coyote Creek
Palo Alto RWQCP
Proposed Palo Alto AWPF
SJ/SC RWF
Sunnyvale WPCP
Palo Alto AWPF Option 1: Conveyance of ROC for blending and discharge at existing RWQCP outfall
Proposed Sunnyvale AWPF
San Jose AWPF Option 1: Conveyance to new outfall located past the existing outfall well
Existing SVAWPC and adjacent Proposed San Jose AWPF
Legend
Alternative
Blending and discharge at existing outfall
Separate nearby outfall / new permit
New shallow outfall with enhanced mixing
Deep-water outfall
N
0
4,000
Feet

Figure 2-14. ROC management strategies, North County (as identified by the ROCMP Team)

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2.2.1 ROC Management for San José AWPF (24 mgd)

The 24-mgd San José AWPF would be located adjacent to the existing 8-mgd SVAWPC. The new AWPF would produce up to 4.2 mgd of ROC[3]. Currently, a portion of SJ/SC RWF's tertiary-treated effluent is recycled by tertiary treatment and distributed via SBWR. Secondary effluent flow feeds SVAWPC for purification for NPR+. The remaining flow is discharged to the SF Bay via an outfall at the Artesian Slough, as regulated under an existing NPDES permit.

The components assumed by the ROCMP team to be required to manage ROC at a San José AWPF for each of the two ROC management options are presented in Table 2-11.

Table 2-11. ROC management strategies for Portfolio 1, San José AWPF (24 mgd)

ROC management option	Components of ROC management option	Capital cost[a]
Option 1: Blending and discharge at new outfall downstream of existing outfall discharge weir	• 9,500 feet 20-inch high-density polyethylene (HDPE) pipe (from AWPF to new outfall) • ROC pump station and holding tank • Outfall diffuser • Optional treatment processes for nutrients and CECs	$40M
Option 2: Discharge at a new shallow outfall at Coyote Creek	• 20,000 feet 20-inch HDPE pipe (from AWPF to new outfall) • ROC pump station and holding tank • Outfall diffuser • Optional treatment processes for nutrients and CECs	$50M

a. *Capital costs in 2019 dollars and rounded up to the nearest $5M. O&M costs not included in most recent ROCMP cost estimate provided. Costs include optional ROC treatment. See Attachment F (Task 5 TM) for details.*

2.2.2 ROCM for Combined Regional AWPF in Palo Alto (24.5 mgd)

Final effluent feed from the Palo Alto RWQCP and the Sunnyvale WPCP, conveyed to Palo Alto via a new pipeline, would feed the 24.5-mgd Combined Regional AWPF in Palo Alto, generating roughly 4.3 mgd of ROC.

The majority of final effluent from the Palo Alto RWQCP is currently discharged to the SF Bay. A small portion is discharged to Matadero Creek, and the remainder is distributed as Title 22-compliant tertiary-treated recycled water. The City of Palo Alto is currently proceeding with a 2.25-mgd AWPF that will blend permeate with tertiary-treated recycled water at a 1:1 ratio to provide NPR+. The AWPF will reduce TDS levels in recycled water from the current range of 770 mg/L-1,100 mg/L down to a target range of 400 mg/L – 500 mg/L as described in the 2017 Advanced Water Purification System Feasibility Study – Final. The existing Palo Alto RWQCP NPDES permit includes a dilution credit of 3.5:1 for copper and a dilution credit of 3.25:1 for cyanide.

The components assumed by the ROCMP team to be required to manage ROC from a Combined Regional AWPF in Palo Alto for each of the three ROC management options are presented in Table 2-12.

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[3] 5.65 mgd is listed in Attachment F, Task 5 TM, for the combined ROC flow from the new AWPF and the existing SVAWPC.

Table 2-12. ROC Management Strategies for Portfolio 2a, Combined Regional AWPF in Palo Alto (24.5 mgd)

ROC management option	Components of ROC management option	Capital cost[a]
Option 1: Blending and discharge at existing RWQCP outfall	• 11,000 ft 18-inch HDPE pipe (from AWPF to existing outfall) • ROC pump station and holding tank	$35M
Option 2: Discharge at a new shallow outfall in San Francisco Bay	• 11,000 ft 18-inch HDPR pipe from AWPF to existing outfall • 5,000 ft 18-inch HDPE pipe to location under SF Bay • ROC pump station and holding tank	$55M
Option 3: Deep water outfall north of Dumbarton Bridge	• 70,000 ft 18-inch HDPE pipe (from AWPF to existing deep-water outfall in Redwood City) • ROC pump station and holding tank	$95M

a. *Capital costs in 2019 dollars and rounded up to the nearest $5M. O&M costs not included in most recent ROCMP cost estimate provided. Costs include optional ROC treatment. See Attachment F (Task 5 TM) for details.*

2.2.3 ROCM for Combined Regional AWPF in Sunnyvale (24.5 mgd)

Final effluent feed from the Sunnyvale WPCP and the Palo Alto RWQCP, piped to the AWPF via a new pipeline, would feed the 24.5-mgd Combined Regional AWPF at Sunnyvale, generating roughly 4.4 mgd of ROC. Final effluent from the Sunnyvale WPCP is currently discharged to the South Bay via Moffett Channel.

The components assumed by the ROCM team to be required to manage ROC from a Combined Regional AWPF in Sunnyvale are presented in Table 2-13.

Table 2-13. ROC management strategies for Portfolio 2b, Combined Regional AWPF in Sunnyvale (24.5 mgd)

ROC management option	Components of ROC management option	Capital cost[a]
Option 1: New shallow outfall at Guadalupe Slough	• 33,000 ft 18-inch HDPE pipe (from AWPF to new outfall location) • ROC pump station and holding tank • Outfall diffuser	$55M

a. *Capital costs in 2019 dollars and rounded up to the nearest $5M. O&M costs not included in most recent ROCMP cost estimate provided. Costs include optional ROC treatment. See Attachment F (Task 5 TM) for details.*

2.2.4 ROC Management for Separate AWPFs in Palo Alto (14 mgd) and Sunnyvale (10.5 mgd)

Operating two separate regional AWPFs with a capacity of 14.0 and 10.5 mgd of production capacity at Palo Alto and Sunnyvale, respectively, would yield maximum ROC flows of 2.5 mgd and 1.9 mgd (Palo Alto and Sunnyvale, respectively). In this case, the WWTPs would not blend their separate streams of treated effluent. Modeling indicates that ROC discharge at Palo Alto for its separate AWPF maintains compliance with existing NPDES permits while discharge from the Sunnyvale AWPF requires a permit negotiation for dilution credits.

The components assumed by the ROCMP team to be required for managing ROC at separate Palo Alto / Sunnyvale AWPFs are presented in Table 2-14.

Table 2-14. ROC Management Strategies for Portfolio 4, Separate AWPFs in Palo Alto (14 mgd) and Sunnyvale (10.5 mgd)

ROC management option	Components of ROC management option	Capital cost[a]
Option 1 Palo Alto: Blending and discharge at existing RWQCP outfall Sunnyvale: New shallow outfall at Guadalupe Slough	• 11,000 ft 14-inch HDPE pipe (from Palo Alto AWPF to existing outfall) • ROC pump station and holding tank at Palo Alto • 33,000 ft 12-inch HDPE pipe (from Sunnyvale AWPF to new outfall) • ROC pump station and holding tank at Sunnyvale • Outfall diffuser at Sunnyvale	$60M
Option 2 Palo Alto: Discharge at a new shallow outfall in SF Bay Sunnyvale: New shallow outfall at Guadalupe Slough	• 15,000 ft 14-inch HDPE pipe from Palo Alto AWPF to beyond existing outfall • 1,000 ft 18-inch HDPE pipe under SF Bay to new outfall • ROC pump station and holding tank at Palo Alto • 33,000 ft 12-inch HDPE pipe (from Sunnyvale AWPF to new outfall) • ROC pump station and holding tank at Sunnyvale • Outfall diffuser at Sunnyvale	$80M
Option 3 Palo Alto: Convey ROC to existing deep water outfall in Redwood City (at Silicon Valley Clean Water) Sunnyvale: New shallow outfall at Guadalupe Slough	• 71,000 ft 14-inch HDPE pipe (from Palo Alto AWPF to existing deep water outfall in Redwood City at Silicon Valley Clean Water) • ROC pump station and holding tank at Palo Alto • 33,000 ft 12-inch HDPE pipe (from Sunnyvale AWPF to new outfall) • ROC pump station and holding tank at Sunnyvale • Outfall diffuser at Sunnyvale	$105M

a. *Capital costs in 2019 dollars and rounded up to the nearest $5M. O&M costs not included in most recent ROCMP cost estimate provided. Costs include optional ROC treatment. See Attachment F (Task 5 TM) for details.*

2.2.5 ROC Management for Morgan Hill AWPF (2 mgd)

The inland location of the Morgan Hill AWPF limits ROC management options. The ROCMP team recommended a single option: convey ROC to a lined evaporation pond near the SCRWA facility in Gilroy.

The components assumed by the ROCMP team to be required to manage ROC from a Morgan Hill AWPF are presented in Table 2-15.

Table 2-15. ROCM Strategies for Portfolio 2b, Combined Regional AWPF in Sunnyvale (24.5 mgd)

ROCM Option	Components of ROCM Option	Capital Cost
Option 1: Conveyance to a lined evaporation pond in/near Gilroy	• 58,600 ft 8-inch HDPE pipe (from AWPF to SCRWA area) • ROC pump station and holding tank • 83-acre pond – land purchase/lease and excavation	$55M

2.3 Conveyance/Distribution

Conveyance and distribution project elements include:

- NPR/NPR+ distribution system expansions
- Interties between recycled water distribution systems
- Effluent pipelines from WWTPs to AWPFs for treatment
- Purified water pipelines from AWPFs to delivery points
- LGRP piping improvements

- Penitencia WTP improvements
- ROCM pipelines
- Pump stations

2.3.1 NPR/NPR+ Distribution Systems

NPR programs are established at each of the WWTPs in the County, and expansion of NPR use is envisioned to be a key water supply for water retailers in the future. A market assessment was presented in Attachment A of Appendix F, Conceptual Alternatives TM, including known potential NPR/NPR+ projects in the County sorted by retailer and distribution system. Since development of the Conceptual Alternatives TM, information has been updated to include additional projects studied by Valley Water and Palo Alto within their service area, as well as indications for how additional recycled water may be used within the SBWR service area through the 2040 planning horizon.

Potential future NPR/NPR+ projects are described below and summarized in Table 2-15.

Palo Alto and East Palo Alto NPR+. On March 2, 2020, Palo Alto's City Council accepted the Final Northwest County Recycled Water Strategic Plan. This report presented three NPR+ concepts within Palo Alto and Los Altos, one in East Palo Alto, and two in Mountain View. The report indicated that Stanford University did not foresee a need for recycled water from the Palo Alto RWQCP due to its use of its lake water system.

Though no specific alternatives were recommended, three of the alternatives—A2: Palo Alto Phase 3 extended to Foothills, A4: Mountain View, and A6: East Palo Alto—were the highest-ranking alternatives.

Alternative A2, the highest ranked conceptual alignment, includes six pump stations and a 1.6-MG storage tank within the Palo Alto RWQCP service area. Pump stations were preliminarily located at the intersections of El Camino Real (Highway 82) and Oregon Expressway, Arastradero Road at Deer Creek Road, Page Mill Road at Arastradero Road, Moffett Field, Charleston Park, and at the Palo Alto RWQCP. Design phasing information and proposed facilities that make up each phase of Alternative A4 are described below.

Mountain View NPR+. Mountain View's 2014 Recycled Water Feasibility Study recommended a phased expansion of the Mountain View Recycled Water System. During Phase 1, approximately 16,700 linear feet (LF) of pipeline in the National Aeronautics and Space Administration (NASA) and Bay View areas, two variable frequency drive units, and a potable backup supply at the RWQCP. Phase 2 adds 9,900 LF of pipe in the Whisman Station and North Whisman neighborhoods, three pump stations, a 1.6-MG tank at NASA, and a 2.9-MG tank at Charleston Park. Phase 3 adds 16,200 LF of pipe to serve Sylvan Park, Cuesta Park, El Camino Hospital, and Cooper Park; and three variable-frequency drive units.

Sunnyvale NPR. NPR was studied by the City of Sunnyvale as part of the Feasibility Study for Recycled Water Expansion (FSRWE). This document identified multiple NPR projects to add up to 2,100 AFY of NPR demand within the City and Cupertino. Valley Water also has the ability, through its existing agreements, to wholesale NPR within its portion of the service area. Additional information about the NPR projects is further detailed in Section A.2 of Appendix F.

SBWR NPR+. NPR demands were updated so that SBWR delivered the projected 2040 recycled water demands identified in Table 2 of Appendix E-1. This resulted in delivery of approximately 2,810 AFY to the City of Milpitas, 9,500 AFY to SJ Muni, 9,000 AFY to the City of Santa Clara, and 9,625 AFY to San Jose Water. Combined, these buildout NPR demands total 30,935 AFY.

All existing demands as of the 2017 calendar year were placed where recycled water meters are currently located. Those actual demands were specifically located based on available information. Peaking factors consistent with existing demands were applied to all buildout demands.

For each retailer, demands were updated as follows:

- *City of Milpitas:* Existing City of Milpitas demands were 1,121 AFY. An additional 1,689 AFY were located at multiple points of connection where the City of Milpitas planned a new recycled water project, which is shown on Figure A.8 in Appendix F. No scaling up of demands were required for City of Milpitas NPR demands.
- *San Jose Water Company:* Existing San Jose Water Company (SJW) NPR demands are 2,697 AFY. Planned recycled water projects add an additional 5,703 AFY of NPR demands. Planned NPR demands were located at specific nodes in the hydraulic model where a turnout between the SBWR system and a future SJW pipeline would be located. To achieve the 9,625 AFY at buildout, an additional 1,225 AFY of demand was applied by scaling up existing and planned NPR demands throughout the SJW service area. See Figure A.7 in Appendix F for proposed alignments.
- *San José Municipal Water System:* Existing NPR demands in the North San José (1,231 AFY) and Edenvale (3,893 AFY) areas of the SJ Muni were continued in the buildout model. SJ Muni projected that additional growth of recycled water would exclusively occur within the North San José service area, and no additional growth was expected in Edenvale. SJ Muni provided a map of locations and magnitude of planned recycled water demand of approximately 1,060 AFY within its North San José service area. An additional 3,316 AFY of demand was not located. To achieve the desired buildout demand of 9,500 AFY within the SJ Muni service area and keep Edenvale demands consistent, the existing demand of 1,231 AFY was scaled up by 3,316 AFY to 4,547 AFY and located at the same location as existing demands.
- *City of Santa Clara:* Existing City of Santa Clara NPR demands of 5,050 AFY were continued in the buildout model. The City of Santa Clara provided a list of and location for an additional 1,534 AFY of recycled water demand from known potential projects in its distribution system. The City indicated that it expects any additional NPR demand (2,416 AFY) outside of existing and potential projects to be located north of Highway 101 and an area near Arques Drive. To achieve the desired buildout demand of 9,000 AFY, existing and proposed demands north of Highway 101 and near Arques Drive were scaled up from their identified values.

Gilroy NPR. The South County Recycled Water Master Plan (RWMP) explored NPR expansion and identified the potential to serve approximately 1,120 AFY of NPR demand by extending the existing recycled water distribution system in Gilroy. Additional information about this concept is further detailed in Section A.4 of Appendix F.

Morgan Hill NPR. The South County Recycled Water Master Plan (RWMP) explored NPR expansion and identified the potential to serve approximately 785 to 2,900 AFY of NPR demand in Morgan Hill via a satellite WWTP producing NPR water or by extending the existing recycled water distribution system in Gilroy north to Morgan Hill. Additional information about this concept is further detailed in Section A.4 of Appendix F. The South County RWMP did not recommend any NPR projects in Morgan Hill. Because NPR in Morgan Hill may be feasible in the context of an integrated countywide plan, potential NPR projects are considered in context of the project portfolios (Section 3.2).

Countywide NPR/NPR+. Table 2-16 presents a summary of potential future NPR and NPR+ projects and associated capital costs as previously studied by retailers in recycled water master plans. Demands shown in this table are not aligned with water suppliers' UWMP NPR/NPR+ demand projections. Existing demands are not reflected in Table 2-16.

Each retailer has different assumptions for what is included in its cost estimates; thus, NPR/NPR+ costs across agencies are not directly comparable. For example, capital costs in this table may or may not include soft costs, retrofits, treatment plant upgrades, pump stations, and/or storage. Some projects identified in Table 2-16 may require the implementation of other projects to feasibly proceed. Additionally, the capacity to provide recycled water during max day or peak hour conditions has not been confirmed.

Table 2-16. Potential Future NPR/NPR+ Projects and Cost Estimates for Recycled Water System Expansions							
	Source Information					Capital Cost 2020 Dollars ($M) d	Annualized Capital Unit Cost ($/AF)
Retailer	ID	Project Name a, b, c	Year	Demand (AFY)	Capital Cost ($M)		
Palo Alto e	NPR-1	A1: Palo Alto Phase 3	2019	800	$47.8	$48.5	$3,100
	NPR-2	A2: Palo Alto Phase 3 Ext. to Foothills	2019	1,100	$63.0	$63.9	$3,000
	NPR-3	A3: Palo Alto Phase 3 Ext. to Foothills and Los Altos	2019	1,200	$85.1	$86.4	$3,700
Palo Alto NPR+ subtotal				1,200			
Mountain View	NPR-4	A4 – Phase 1 Short-Term Expansion	2014	588	$4.9	$5.7	$500
	NPR-5	A4 – Phase 2 Mid-Term Expansion	2014	316	$18.8	$22.0	$3,600
	NPR-5a	A4 – Phase 2 Long-Term Expansion	2014	221	$4.6	$5.4	$1,200
Mountain View NPR+ subtotal				1,125			
East Palo Alto	NPR-6	A6: East Palo Alto	2019	500	$20.7	$21.0	$2,100
East Palo Alto NPR+ subtotal				500			
PA/MV RWS Subtotal				2,825			
Sunnyvale f	NPR-7	Lakehaven Drive	2013	86	$1.41	$1.7	$1,000
	NPR-8	Maude Avenue	2013	36	$1.36	$1.6	$2,300
	NPR-9	Duane Avenue	2013	429	$5.62	$6.7	$800
	NPR-10	Kifer Road East	2013	51	$1.33	$1.6	$1,600
	NPR-11	Kifer Road West	2013	54	$0.78	$0.9	$900
	NPR-12	Main Loop	2013	335	$15.9	$19.1	$2,900
	NPR-13	Iris Avenue	2013	55	$0.63	$0.8	$700
	NPR-14	Marion Way	2013	30	$0.65	$0.8	$1,300
	NPR-15	Dartshire Way	2013	65	$1.37	$1.6	$1,300
	NPR-16	Gail Avenue	2013	39	$0.58	$0.7	$900
	NPR-17	Old San Francisco Road	2013	26	$0.45	$0.5	$1,100
	NPR-18	Manet Drive	2013	86	$0.45	$0.5	$300
	NPR-19	Sunnyvale-Saratoga Road	2013	14	$0.60	$0.7	$2,600
	NPR-20	Remington Drive	2013	59	$1.75	$2.1	$1,800
	NPR-21	Carson Drive	2013	16	$0.37	$0.4	$1,400
Sunnyvale NPR subtotal				1,381			
Sunnyvale RWS Subtotal				1,381			
Milpitas g	NPR-22	Segments 1 through 5	2016	751	$45	$49.3	$3,400
Milpitas NPR+ subtotal				751			
SJW h	NPR-23	Alignment L: Lewis Street	2011	589	$10.4	$12.9	$1,100
	NPR-24	Alignment P: Quimby Road	2011	1731	$38.3	$47.6	$1,400
	NPR-25	Alignment K: West Hedding	2011	184	$4.27	$5.3	$1,500
	NPR-26	Alignment Q: Curtner	2011	2,421	$58.2	$72.4	$1,500
	NPR-27	Alignment I: Dolores	2011	70	$1.92	$2.4	$1,700
	NPR-28	Alignment E: Mabury Road (Phases 1 and 2)	2017	1,147	$15.0	$16.4	$700
	NPR-29	Alignment J: Saratoga	2011	97	$3.07	$3.8	$2,000
	NPR-30	Cupertino Extension	2012	2,100	$55.0	$67.3	$1,600

Table 2-16. Potential Future NPR/NPR+ Projects and Cost Estimates for Recycled Water System Expansions

	Source Information					Capital Cost 2020 Dollars ($M) [d]	Annualized Capital Unit Cost ($/AF)
Retailer	**ID**	**Project Name [a, b, c]**	**Year**	**Demand (AFY)**	**Capital Cost ($M)**		
		SJW NPR+ subtotal		8,339			
SJ Muni		No specific projects. This is a buildout projection.	N/A	4,376	N/A	N/A	N/A
		SJ Muni NPR+ subtotal		4,376			
Santa Clara		No specific projects. This is a buildout projection.	N/A	2,416	N/A	N/A	N/A
		Identified future customers (see Appendix C)	N/A	1,534	N/A	N/A	N/A
		Santa Clara NPR+ subtotal		3,950			
		SBWR Subtotal		17,416			
Gilroy [i]	NPR-31	Immediate Term Projects	2016	672	$14.3	$15.9	$1,200
	NPR-32	Short-Term Projects	2016	224	$9.97	$11.1	$2,500
	NPR-33	Long-Term Projects	2016	224	$10.0	$11.1	$2,500
		Gilroy NPR subtotal		1,120			
Morgan Hill [i]	NPR-34	Options MH-1 and MH-2 (1 mgd with SCRWA transmission main)	2016	345-495	$41-48	$45.7-53.5	$4,700-$7,900
	NPR-35	Options MH-1 and MH-5 (1 mgd with Morgan Hill trunk line scalping plant)	2016	345-495	$33.8-$37.4	$37.7-$41.7	$3,900-$6,200
	NPR-36	Options MH-3 and MH-4 (2.25 mgd buildout with SCRWA transmission main)	2016	785	N/A	N/A	N/A
	NPR-37	Options MH-6 and MH-7 (2.25 mgd buildout with Morgan Hill trunk line scalping plant)	2016	785	N/A	N/A	N/A
	NPR-38	Market assessment (total potential NPR)	2016	2,877	N/A	N/A	N/A
		Morgan Hill NPR subtotal		345- 2,877			
		SCRWA Subtotal		1,465-3,997			
		Countywide NPR/NPR+ TOTAL		23,087-25,619			

a. *All projects are listed to the extent feasible. Not all projects can be implemented independently. Some projects may require other projects (pipelines, tanks, pump stations, treatment plants, or retrofits) to be completed.*

b. *Source projects that combined IPR or DPR with NPR projects are not listed in this table.*

c. *The projects presented in this table are not mutually exclusive. Some projects were originally presented as options that may have included portions of other projects also presented in this table.*

d. *Cost escalation is based on California Construction Cost Index (CCCI) from Department of General Services (https://www.dgs.ca.gov/RESD/Resources/Page-Content/Real-Estate-Services-Division-Resources-List-Folder/DGS-California-Construction-Cost-Index-CCCI). Original CCCI were taken from dates of reference document and escalated using April 2020 CCCI of 6955.*

e. *For the Palo Alto RWQCP, all information was taken from the Recycled Water Strategic Plan Report – Northwest County Recycled Water Strategic Plan, Interim Final Report, July 2019. It was assumed this information superseded reports by various retailers in this service area.*

f. *For the Sunnyvale WPCP, all information came from the Feasibility Study for Recycled Water Expansion, June 2013.*

g. *For Milpitas, source is City of Milpitas Recycled Water Pipeline Project Final IS/MND, October 2016.*

SJW segments were from RWMP Update, 2011. SJW Alignment E cost and demands were updated in 2017.

Gilroy and Morgan Hill projects do not include planned SCRWA WWTP project costs. All data comes from the 2015 South County Recycled Water Master Plan Update, May 2016

Figure 2-15 shows the NPR/NPR+ expansions that have been identified from various planning reports or in collaboration with agencies.

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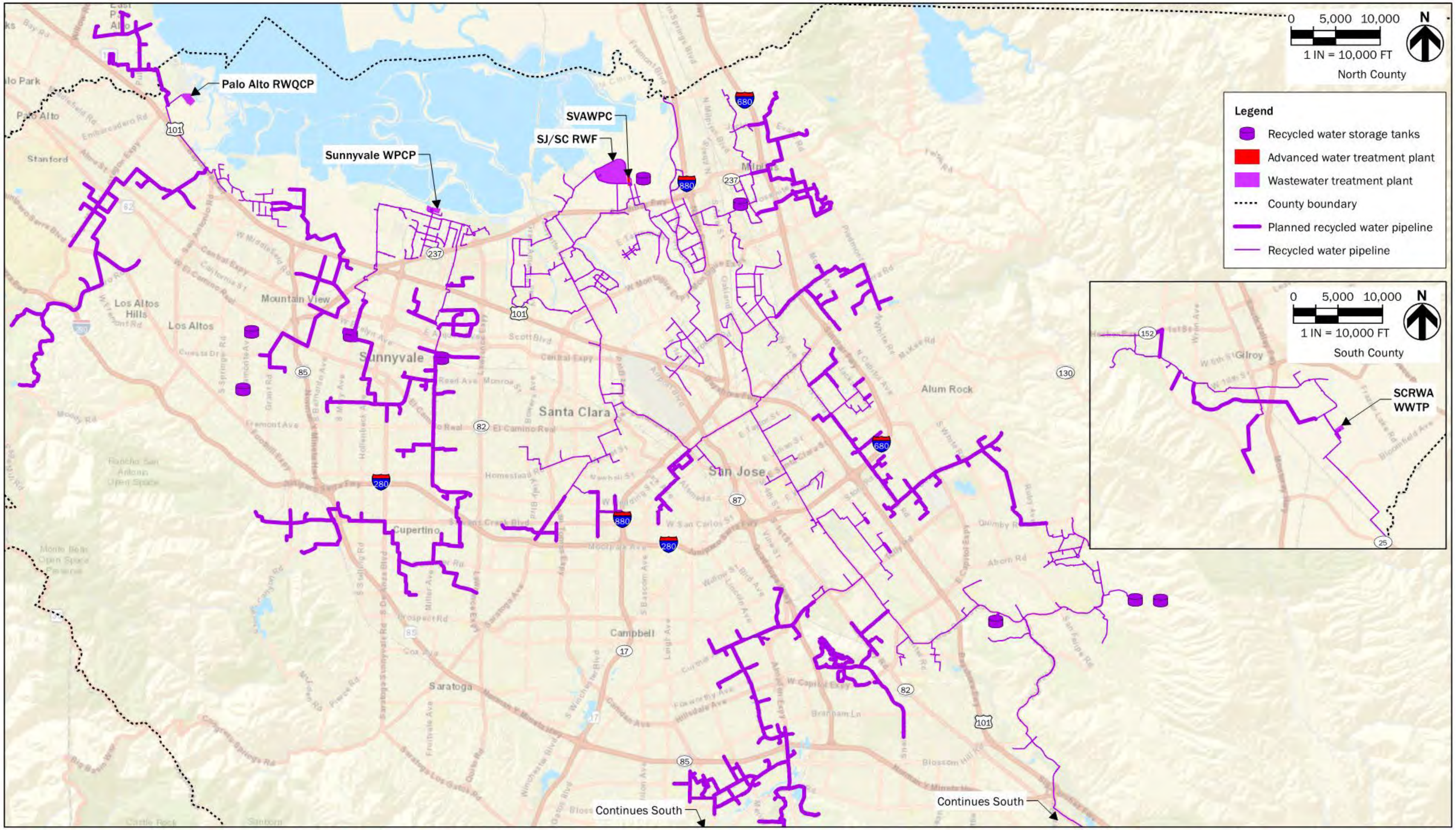

Figure 2-15. Expansion of existing NPR/NPR+ distribution systems Countywide

Note: City of Santa Clara and SJ Muni recycled water infrastructure improvements are currently undefined.

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2.3.2 Interties between Recycled Water Systems

The interconnection of recycled water systems has several potential functions, including:

1. **Reliability:** If an outage occurs in one system, available capacity from an adjoining system could be used. Supply from an adjoining system could also support pipeline maintenance activities, such as shutdowns of transmission mains.
2. **Peak demand supply mitigation:** Peak day and peak hour demands are a challenge in some systems, and supply from an adjoining system could be leveraged to meet demands.
3. **Freeing up effluent for PR:** By meeting NPR demands of adjacent systems, the amount of supply offset could provide more flow for PR or ROCM dilution. For example, if Sunnyvale's NPR demand was met by SBWR, Sunnyvale could provide more supply for PR or ROCM dilution. Vice versa, if SBWR's NPR+ expansion was met using effluent from Sunnyvale, SBWR would be able to confidently meet NPR+ demands even during dry years, allowing for supply for PR.

Interties may require pump stations, pressure-reducing valves, or other facilities depending on the function and operation. Additionally, interties between recycled water distribution systems would need to be accompanied by treatment improvements (i.e., an AWPF for NPR+) to avoid negatively impacting the water quality of a neighboring system. Pipeline alignments have been studied for four intertie opportunities in North County, as summarized in Table 2-17 and shown in Figure 2-16.

Table 2-17. Summary of Potential Recycled Water System Interties

Alignment[a]	Description	Key Assumptions/Features	Pipe Length/ Diameter	Capital Cost (2019$)	Source
Sunnyvale – SBWR Interties					
Effluent intertie	Proposed 30-inch pipeline to convey secondary effluent from the Sunnyvale WPCP to the SJ/SC RWF or SVAWPC	5 trenchless crossings 50% of alignment requires tunneling due to Bay soils and high groundwater Sizing assumes 10 mgd; actual flow availability to be determined through discussions with Sunnyvale	32,000 LF 30-inch	$86M	See note[b]
Recycled water intertie, northern connector [a]	Connection of existing SBWR 30-inch pipeline located at Lafayette Drive and Tasman Road to an existing 24-inch Sunnyvale pipeline at Sunnyvale East Channel and Persian Drive Hydraulically modeled to deliver peak recycled water demand of 2.7 mgd from SBWR to Sunnyvale	2 trenchless crossings (Guadalupe River and Calabazas Creek)	16,000 LF 24-inch	$14.5M	See note[c]
		4 trenchless crossings 50% of alignment requires tunneling due to Bay soils and high groundwater Modeling indicates new pump station is necessary to connect to SBWR	15,000 LF 30-inch	$51.1M	See note[b]
		1 trenchless crossing	15,000 LF 30-inch	$23M	See note[d]
Recycled water intertie, southern connector [a]	Connection of existing 16-inch SBWR pipeline at Homestead Rd and Las Palmas Dr to existing Wolfe Rd pipeline Hydraulically modeled to deliver peak recycled water demand of 2.7 mgd from SBWR to Sunnyvale	2 trenchless crossings	12,000 LF 16-inch	$7M	See note[c]
		3 trenchless crossings Modeling indicates alignment would result in a large pressure increase in the SBWR system; cost and detailed alignment analysis was not performed	12,000 LF 30-inch	Not prepared	See note[b]
Sunnyvale – Mountain View intertie					
Recycled water intertie	Connection of existing 16-inch pipeline on Enterprise Way in Sunnyvale to a new 16-inch recycled water pipeline located in Moffett Field that would connect to the Mountain View recycled water distribution system	Pipeline could serve new customers in Mountain View's North Bayshore area and within NASA and the Bay View area outside the existing service area.	18,600 LF 16-inch	$16M	See note[e]

a. *All recycled water alignments require an AWPF for NPR+ in Sunnyvale to reduce salinity to levels consistent with SBWR.*

b. *Sunnyvale Source Water Augmentation Facilities Plan, RMC 2018*

c. *TM2: Modeling of Regional Sunnyvale/ SBWR Recycled Water Distribution System HydroScience 2011*

d. *San Jose Water, 2011. Recycled Water Master Plan – 2011 Update Draft. Prepared by HydroScience Engineers, Inc.*

e. *City of Mountain View, 2014. Recycled Water Feasibility Study. Prepared by Carollo Engineers.*

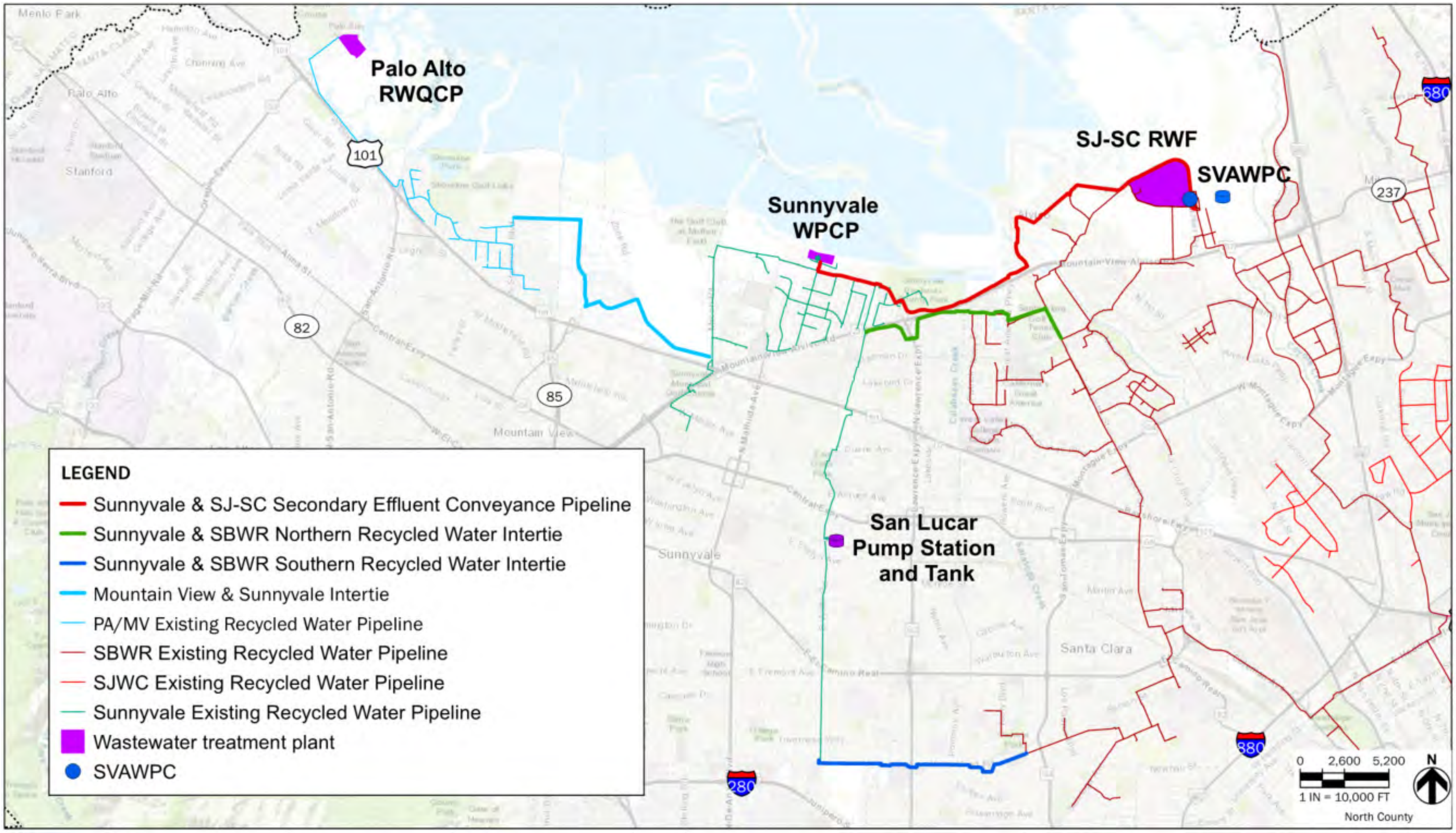
Palo Alto RWQCP
SJ-SC RWF
SVAWPC
Sunnyvale WPCP
San Lucar Pump Station and Tank
Menlo Park
Palo Alto
Stanford
Mountain View
Sunnyvale
Santa Clara
101
82
85
237
280
680
880
LEGEND
Sunnyvale & SJ-SC Secondary Effluent Conveyance Pipeline
Sunnyvale & SBWR Northern Recycled Water Intertie
Sunnyvale & SBWR Southern Recycled Water Intertie
Mountain View & Sunnyvale Intertie
PA/MV Existing Recycled Water Pipeline
SBWR Existing Recycled Water Pipeline
SJWC Existing Recycled Water Pipeline
Sunnyvale Existing Recycled Water Pipeline
Wastewater treatment plant
SVAWPC
0 2,600 5,200
1 IN = 10,000 FT
N
North County

Figure 2-16. Potential recycled water system interties

2.3.3 PR Conveyance Infrastructure

PR conveyance elements include effluent pipelines that send source water from WWTPs to treatment facilities, purified water pipelines that send purified water from treatment facilities to delivery points, pump stations that push/pull water through these pipelines, and delivery point improvements, such as pipeline rehabilitation and the installation of new tanks and pumps.

Effluent Pipelines

One possible alignment was considered for each effluent pipeline due to infeasibility of other potential alternative alignments in each location.

- A new 36-inch pipeline from the Palo Alto RWQCP to the proposed Palo Alto Regional AWPF sized to be able to convey 18.1 mgd of effluent to produce 14 mgd of purified water.
- A new 36-inch effluent pipe from the Sunnyvale WPCP to the proposed Palo Alto Regional AWPF would convey 13.6 mgd of effluent to produce 10.5 mgd of purified water.
- A new 36-inch effluent pipeline from the Palo Alto RWQCP to the proposed Sunnyvale Regional AWPF would convey 18.1 mgd of effluent to produce 14 mgd of purified water.
- A new 36-inch effluent pipe from the Sunnyvale WPCP to the proposed Sunnyvale Regional AWPF would convey 13.6 mgd of effluent to produce 10.5 mgd of purified water. The Sunnyvale WPCP is located across the street from the proposed Sunnyvale AWPF.
- A new 48-inch pipeline to convey secondary or tertiary effluent from the SJ/SC RWF to the San José AWPF. The pipeline would convey flow from either the existing secondary clarifiers or tertiary filters to the influent pump station of the San José AWPF.

Purified Water Pipelines

Palo Alto AWPF to LGRP: Four alignments to convey purified water from the Palo Alto AWPF site to LGRP were evaluated. Each of these route variations offers potential advantages; key considerations for each alignment are summarized below.

- **Eastern route, via Sunnyvale WPCP.** This route would use the alignment recommended in the Expedited Purified Water Program Plan (for transporting purified water from San José to LGRP). Though this alignment has the longest length of any purified water option extending from Palo Alto to LGRP, it offers potential to easily add purified supply from SJ/SC RWF in the future due to its central location.
- **Western route, via Sunnyvale WPCP.** As considered in the Sunnyvale FSRWE, this alternative would use the Wolfe Road pipeline as a purified water supply. This alternative does not require trenchless construction to cross Highway 280. Though adding purified supply from SJ/SC RWF would require a longer purified water pipeline, this route is closest to Rinconada WTP, which could enable future RWA.
- **Western route, bypassing Sunnyvale WPCP.** In addition to requiring a shorter pipeline than options going through Sunnyvale WPCP, this route would not require trenchless construction for crossing Highways 280, 101, and 237; however, trenchless construction would be needed to cross a creek, Valley Transit Authority, and San Francisco Public Utilities Commission (SFPUC) facilities. Though adding purified supply from SJ/SC RWF would require a longer purified water pipeline, this route is closest to Rinconada WTP, which could enable future RWA.
- **Eastern route, bypassing Sunnyvale.** This is the shortest pipeline option of any alternative. Crossing Highways 237 and 101 would not require trenchless construction, though it would be required to cross Highway 280, a creek, Valley Transit Authority, and SFPUC facilities. South of Arques, this option mirrors the Expedited Purified Water Program Plan recommended alignment.

Palo Alto AWPF to West Pipeline (TWA): A new pipeline would convey purified water treated for TWA almost 11 miles to a delivery point along Valley Water's existing West pipeline.

Sunnyvale AWPF to LGRP: Two purified water alignments from the Sunnyvale AWPF to LGRP were considered. Starting at the Sunnyvale AWPF, these alignments are identical to the eastern and western route (via Sunnyvale) considered for conveying purified water from the Palo Alto AWPF to LGRP. These purified water alignment options (eastern and western) were studied in the Expedited Purified Water Program Plan (Valley Water, 2018a) and Sunnyvale's Feasibility Study for Recycled Water Expansion Report (City of Sunnyvale, 2013b).

San José AWPF to LGRP. One purified water pipeline alignment is recommended from the San José AWPF to LGRP based on an alignment studied in the Expedited Purified Water Program Plan (Valley Water, 2018a). A new 48-inch, 18-mile pipeline would convey up to 24 mgd of purified water.

San José AWPF to SBA terminal tank (RWA). One purified water pipeline alignment is recommended from the San José AWPF to the SBA terminal tank at the Penitencia WTP as previously evaluated as part of the Expedited Purified Water Program Plan (Valley Water, 2018a). A new 48-inch, 9-mile pipeline would convey up to 24 mgd of purified water.

San José AWPF to North Side Tanks (TWA). One new purified water pipelines alignment is recommended from the San José AWPF to North Side Storage Tanks to serve the cities of San José and Santa Clara (portions north of Highway 101). A new 24-inch, 5-mile pipeline would convey about 4 mgd of purified water.

San José AWPF to Milpitas pipeline (TWA). One purified water pipeline alignment is recommended from the San José AWPF to the Gilbraltar Reservoir where water could be introduced to the Milpitas pipeline. A new 36-inch, 4-mile pipeline would convey up to 20 mgd of purified water.

San José AWPF to Piedmont Valve Yard (TWA). One purified water pipeline alignment is recommended from the San José AWPF to the Piedmont Valve Yard where water could be introduced to the Milpitas pipeline or Valley Water's East pipeline. A new 36-inch, 8-mile pipeline would convey up to 20 mgd of purified water.

Pump Stations

Palo Alto. One effluent pump station would be needed to deliver effluent from the Palo Alto RWQCP to a new AWPF in Palo Alto; if also supplied by the Sunnyvale WPCP, an additional effluent pump station (located at Sunnyvale WPCP) would be needed. One purified water pump station, located at the Palo Alto AWPF, would be required to pump purified water to LGRP.

Sunnyvale. One purified water pump station is needed to deliver water from a Sunnyvale AWPF to LGRP. Assuming the Sunnyvale AWPF is located at Recycle Hill, an effluent pump station would be necessary to supply Palo Alto RWQCP effluent to the Sunnyvale AWPF (but not from Sunnyvale WPCP to the Sunnyvale AWPF).

San José. A pump station would be required to deliver approximately 24 mgd to a total dynamic head (TDH) of approximately 585 feet. If located at the San José AWPF, there would be no booster pump stations between the AWPF and the Penitencia WTP.

Other Conveyance Infrastructure

LGRP Improvements. The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water. These improvements were previously evaluated as part of the Expedited Purified Water Program Plan (Valley Water, 2018a).

Penitencia WTP Improvements. Upgrades to the existing Penitencia WTP would be required for it to accept purified water. These improvements were previously evaluated as part of the Expedited Purified Water Program Plan (Valley Water, 2018a).

Rinconada WTP Extension. A pipeline extension from LGRP to Rinconada WTP would allow the option to use GWR infrastructure for RWA. No WTP improvements were assumed to be needed at Rinconada.

Section 3: Portfolio Development

The development of portfolios (formerly called alternatives) began in 2018 with identifying five conceptual portfolios and engaging Partner Agencies to select three conceptual portfolios and a variety of project elements for further development and evaluation. The project elements described and detailed in Section 2 represent those with the highest interest, most likely feasibility, and/or ability to meet partner and program goals.

While project elements were developed individually (with separate cost estimates shown in Attachment D), they can be combined in a variety of ways to create Countywide reuse portfolios for comparison on an economic, regulatory, institutional, and environmental basis. For the purpose of this TM, project elements are grouped and evaluated as follows.

- **NPR/NPR+ distribution system expansion** applies consistently across all portfolios and is, therefore, not considered a differentiator in the portfolio evaluation (Section 5).
- **South County reuse options** can be included in combination with any portfolio and, therefore, are evaluated separately from the portfolios (in Section 5.3).
- **Baseline elements** comprise each portfolio and are evaluated collectively by portfolio.
- **Alternative elements** are options that have been explored and remain separate from portfolios as possible “add-on” items (e.g., interties) or substitutions (e.g., alternative alignments). These elements are included for consideration due to their potential benefits, though they are not included in the evaluation in Section 5, which focuses on comparing the differences among portfolios.

With a major goal of producing 24,000 AFY of PR, the conceptual portfolios selected for this evaluation each included a major PR project element(s) with source flow from the major North County WWTPs, including the SJ/SC RWF, Palo Alto RWQCP, and Sunnyvale WPCP. Using flows from these major facilities is the only way to potentially meet the 24,000 AFY goal. The core element of the three portfolios include:

- Portfolio 1: San José AWPF
- Portfolio 2: Combined Palo Alto/Sunnyvale Regional AWPF for GWR at LGRP
- Portfolio 4: Separate Palo Alto and Sunnyvale AWPFs for GWR at LGRP

The following sections present and compare the NPR projects, the South County opportunities, and core project elements of the three portfolios.

3.1 NPR/NPR+ Expansion (Featured in All Portfolios)

NPR/NPR+ expansion is expected to occur throughout the County and be implemented in numerous water retailer service areas. NPR use and economics associated with expansion evolve over time, and new opportunities arise with changes in land use and business-driven development or redevelopment. A significant industrial NPR demand, such as a cooling tower for a data center, is likely a cost-effective investment to serve. Company/business-driven sustainability initiatives also provide private funding to support water reuse infrastructure implementation.

Other benefits of NPR are that it can minimize the need to increase potable water system capacity and treatment and, relative to producing water for PR, is often a lower-cost water supply to produce from an energy and chemical perspective.

3.2 Portfolio 1 - San José AWPF

Portfolio 1 is centered on using available effluent from the SJ/SC RWF and a new AWPF located adjacent to the existing SVAWPC in San José. Relevant AWPF project elements described in Section 2 identify delivery points for GWR, RWA, and TWA. Corresponding project elements include a PR conveyance pipeline from the AWPF to the delivery points, and infrastructure improvements at the delivery point for integrating purified water into supply/existing systems. The following sections summarize the PR project elements for the four portfolios and the capital and O&M cost estimates.

3.2.1 Portfolio 1a – San José AWPF for GWR (LGRP)

Portfolio 1a delivers up to 24,000 AFY to LGRP for groundwater replenishment (Figure 3-1). Regulations for this portfolio are established with at least nine GWR projects permitted and in operation throughout the state, and more than a dozen more in planning or construction.

The proposed 18-mile pipeline from the AWPF to LGRP would traverse through highly urbanized settings with significant utilities and temporary community disruption. Infrastructure improvements at LGRP would enhance the operational capabilities and allow some ponds to be taken out of service without impacting the entire complex. Using the LGRP system is attractive, as groundwater modeling indicates travel time to the nearest potable supply wells is more than 12 months.

Table 3-1 summarizes Portfolio 1a facilities.

Table 3-1. Portfolio 1a Facilities Summary

Element	Criteria	Quantity	Unit	Notes
San José AWPF for GWR	Capacity	24	mgd	24 mgd for potable reuse; 0.5 mgd for NPR+ in Sunnyvale
Annual yield				
Annual yield	Upper bound	24,000	AFY	Based on purified water production capacity
	Lower bound	19,000	AFY	Long-term PR usage may be limited by groundwater basin capacity, based on Valley Water's WEAP modeling (Valley Water, 2019b)
Pump stations				
PS-1	Flow	16,700	gpm[a]	Purified water delivery to LGRP
	TDH	400	ft	
Effluent and conveyance pipelines				
PL-1	Diameter	60	in	Effluent from SJ/SC RWF to San José AWPF
	Length	2,000	ft	
PL-2	Diameter	48	in	Purified water from San José AWPF to LGRP
	Length	18.1	miles	
Delivery point improvements				
LGRP improvements	n/a	n/a	n/a	The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water (Valley Water, 2018a)
ROCM pipeline				
ROCM pipeline	Diameter	20	in	
	Length	9,600	ft	

a. 1 gpm = 0.00144 mgd

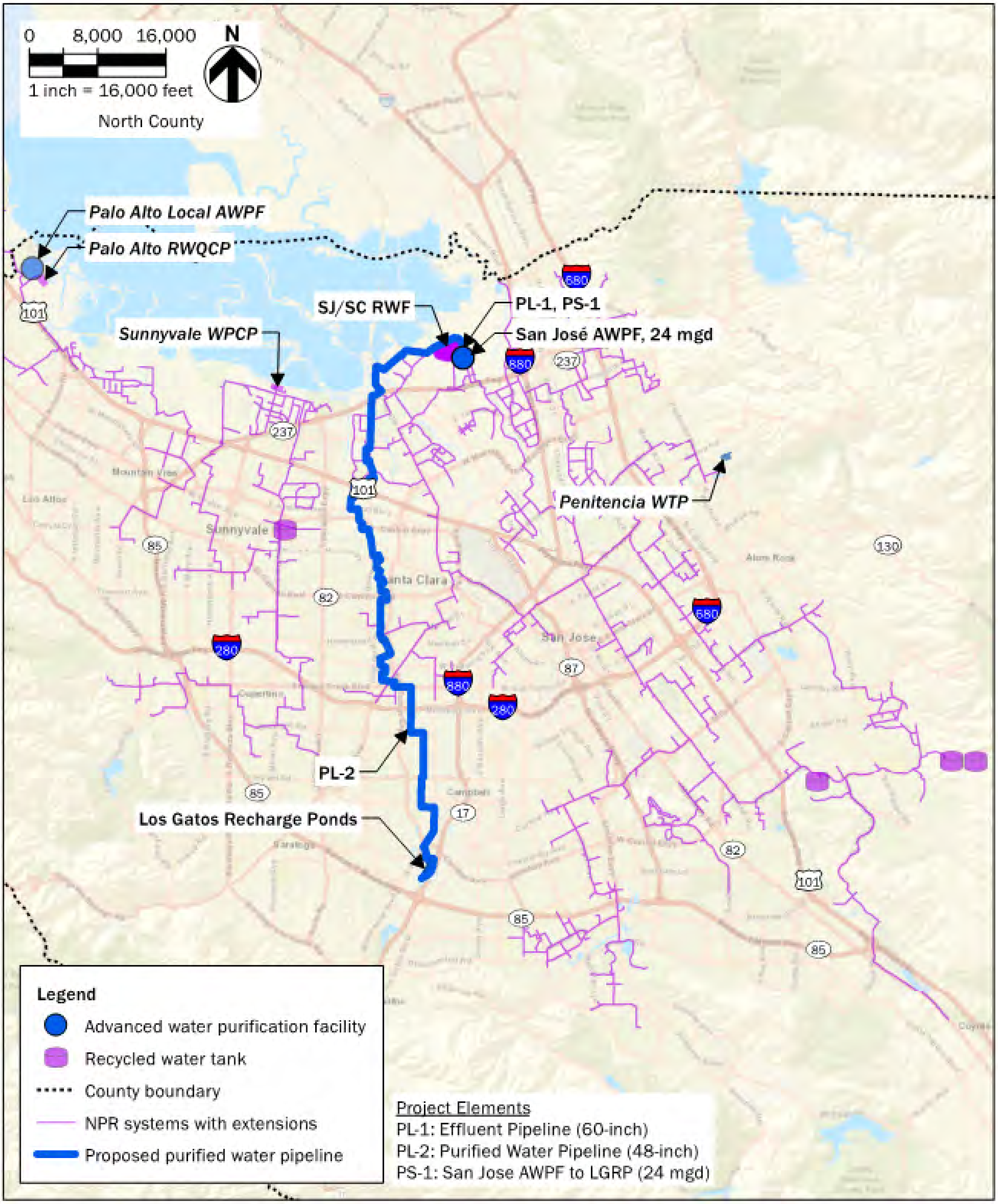

Figure 3-1. Portfolio 1a PR from San José AWPF for GWR (LGRP)

Table 3-2 contains estimated capital and annual O&M costs for Portfolio 1a elements, presented in 2019 dollars.

Table 3-2. Portfolio 1a Estimated Cost Summary from San José AWPF for GWR (LGRP)[a]

Element	Capital Cost ($2019, in millions)	Annual O&M Cost ($2019, in millions)
AWPF (San José 24 mgd)	$310	$13.7
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water) Purified pipeline (San José AWPF to LGRP) LGRP improvements Pipeline easements	$320	$2.3
Annual Potable Reuse Supply	--	$2.4
Total, without ROCM	$630	$18.4
ROCM (existing outfall)	$20	$1.8
Total, with ROCM	$650	$20.2

a. All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000

3.2.2 Portfolio 1b – San José AWPF for RWA (Penitencia WTP)

Portfolio 1b delivers up to 24,000 AFY to the SBA terminal tank located at Penitencia WTP. As discussed in Section 2, DDW is currently in the process of developing RWA regulations and expects to establish the regulations in 2023. Throughout the state, several projects are being discussed with regulators. Due to regulatory uncertainty, the preliminary design for the San José AWPF for RWA incorporates additional disinfection (ozone) and filtration (biologically active GAC) processes to the multi-process treatment train as the basis for planning and cost estimates.

Blending purified water into the SBA terminal tank and the associated pipeline connecting to the Penitencia FM would integrate purified water into Penitencia WTP and the Central Pipeline, which conveys water to the system that feeds Rinconada WTP. The Central Pipeline also has a turnout to the LGRP system. Based on Valley Water's Water Evaluation and Planning System (WEAP) modeling, Portfolio 1b has the same groundwater replenishment benefits as the portfolios that deliver purified water directly to LGRP.

Compared with other portfolios, the connection to the raw water system supports multiple pathways for purified water to be used in various types of water years. The conveyance pipeline from the San José AWPF to Penitencia WTP would be approximately 9 miles—less than half the pipeline length required by other portfolios. Figure 3-2 shows the proposed pipeline path from the San José AWPF to the Penitencia WTP.

Table 3-3 summarizes Portfolio 1b facilities. Table 3-4 contains estimated capital and annual O&M costs for Portfolio 1b elements, presented in 2019 dollars.

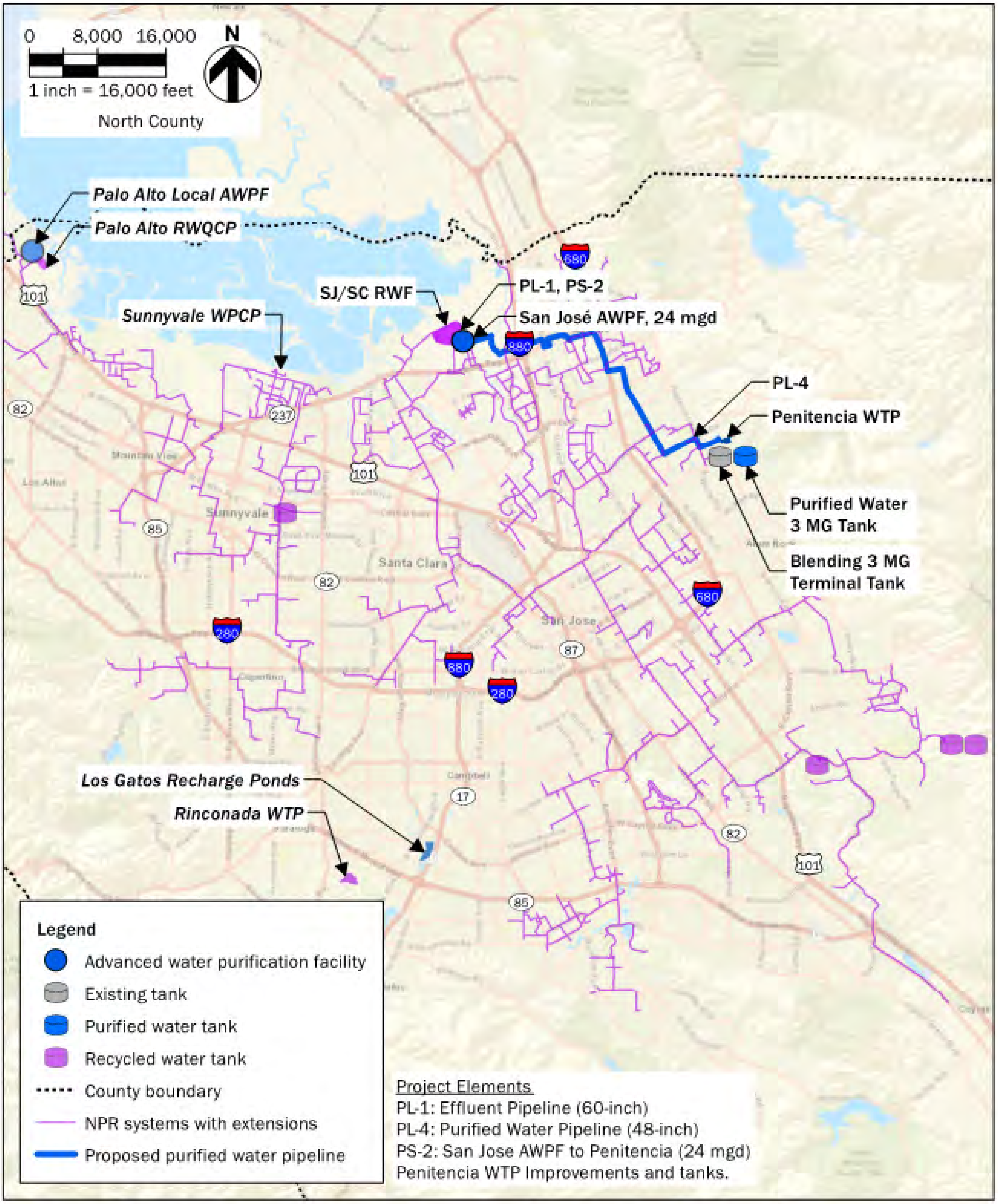

Figure 3-2. Portfolio 1b PR overview

Table 3-3. Portfolio 1b Facilities Summary

Element	Criteria	Quantity	Unit	Notes
San José AWPF for RWA	Capacity	24	mgd	
Annual yield				
Annual yield	Upper bound	24,000	AFY	Based on purified water production capacity
	Lower bound	19,800	AFY	Long-term PR usage may be limited by groundwater basin capacity (due to indirect groundwater benefits), based on Valley Water's WEAP modeling (Valley Water, 2018b)
Pump stations				
PS-2	Flow	16,700	gpm[a]	Purified water delivery to new 3-MG purified water storage tank[b]
	TDH	550	ft	
Effluent and conveyance pipelines				
PL-1	Diameter	60	in	Effluent from SJ/SC RWF to San José AWPF
	Length	2,000	ft	
PL-4	Diameter	48	in	Purified Water from San José AWPF to SBA at Penitencia WTP
	Length	8.9	miles	
Delivery point improvements				
Penitencia purified water storage	Volume	3	MG	
Penitencia sodium bisulfite system (storage and pump system)	n/a	n/a	n/a	Penitencia WTP already has a calcium thiosulfate system that may have capacity for this application
Blend pipe and pipelines	n/a	n/a	n/a	
ROCM pipeline				
ROCM pipeline	Diameter	20	in	
	Length	9,600	ft	

a. 1 gpm = 0.00144 mgd

b. 3-MG storage tank is sized to provide about 3 hours' worth of operational purified water storage at Penitencia. If the AWPF is offline, Valley Water could request a transfer from the State Water Project, which has an assumed 3- to 4-hour response time. (Valley Water, 2018a)

Table 3-4. Portfolio 1b Estimated Cost Summary[a]

Element	Capital Cost ($2019, in millions)	Annual O&M Cost ($2019, in millions)
AWPF (San José 24 mgd for RWA)	$370	$13.8
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water) Purified pipeline (San José AWPF to Penitencia WTP) Penitencia WTP Improvements Pipeline easements	$245	$2.7
Annual Potable Reuse Supply	--	$2.4
Total, without ROCM	$615	$18.9
ROCM (existing outfall)	$20	$1.8
Total, with ROCM	$635	$20.7

a. All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000

3.2.3 Portfolio 1c and 1d – San José AWPF for TWA

Both Portfolio 1c and 1d would produce up to 24,000 AFY that could be used locally and/or conveyed down to the Piedmont Valve Yard for blending and distribution. As discussed in previous sections, DDW is currently in the process of developing DPR regulations. Ensuring adequate systems are in place to protect against treatment and water quality issues that could lead to the distribution of off-spec (or potentially off-spec) water will be critical. To help mitigate some of these concerns, the design of the San José TWA AWPF's include baffled clearwells that should provide: (a) the ability to respond to upstream performance and water quality issues; (b) hydraulic buffering to manage demands in the distribution system; and (c) a location to divert off-spec water upstream of distribution.

The DPR framework identifies that alternative water supplies will be required for TWA. Back-up water supply is critical for reliability; systems need the ability to provide an alternate potable water supply on a similarly rapid timescale. For this assessment, a maximum of 25 percent purified water contribution for potable water replacement is assumed on an average annual basis, as is the potential for retailers and/or Valley Water to consider implementing emergency response measures to reduce demands by 25 percent in the event of an off-spec diversion while switching over to alternative supplies.

Compared to other portfolios, directly connecting to a potable water system supports multiple pathways for using purified water during various water year types. The purified water produced by these TWA portfolios will provide a new source of reliable, local, drought-resistant supply to Valley Water wholesale customers in Santa Clara County to bolster their existing water supply portfolios. Figures 3-3 and 3-4 show the proposed pipelines and general locations for introducing purified water to potable systems for Portfolios 1c and 1d, respectively. Both Portfolio 1c and 1d have pipelines sized to deliver approximately 4 mgd to the North Side Storage Tanks for use by the City of Santa Clara and SJ Muni water distribution systems north of Highway 101. Portfolio 1c and 1d differ in the method for conveying water to Valley Water's Piedmont Valve Yard (near Penitencia WTP) south to treated water turnouts along the East Pipeline. In Portfolio 1c, water would be conveyed via a new pipeline to the Gibraltar Reservoir at the north terminus of the existing Milpitas pipeline for transport to Piedmont Valve Yard, while in Portfolio 1d a new pipeline would deliver water all the way to the Piedmont Valve Yard.

Tables 3-5 and 3-6 summarize Portfolio 1c and 1d facilities, respectively.

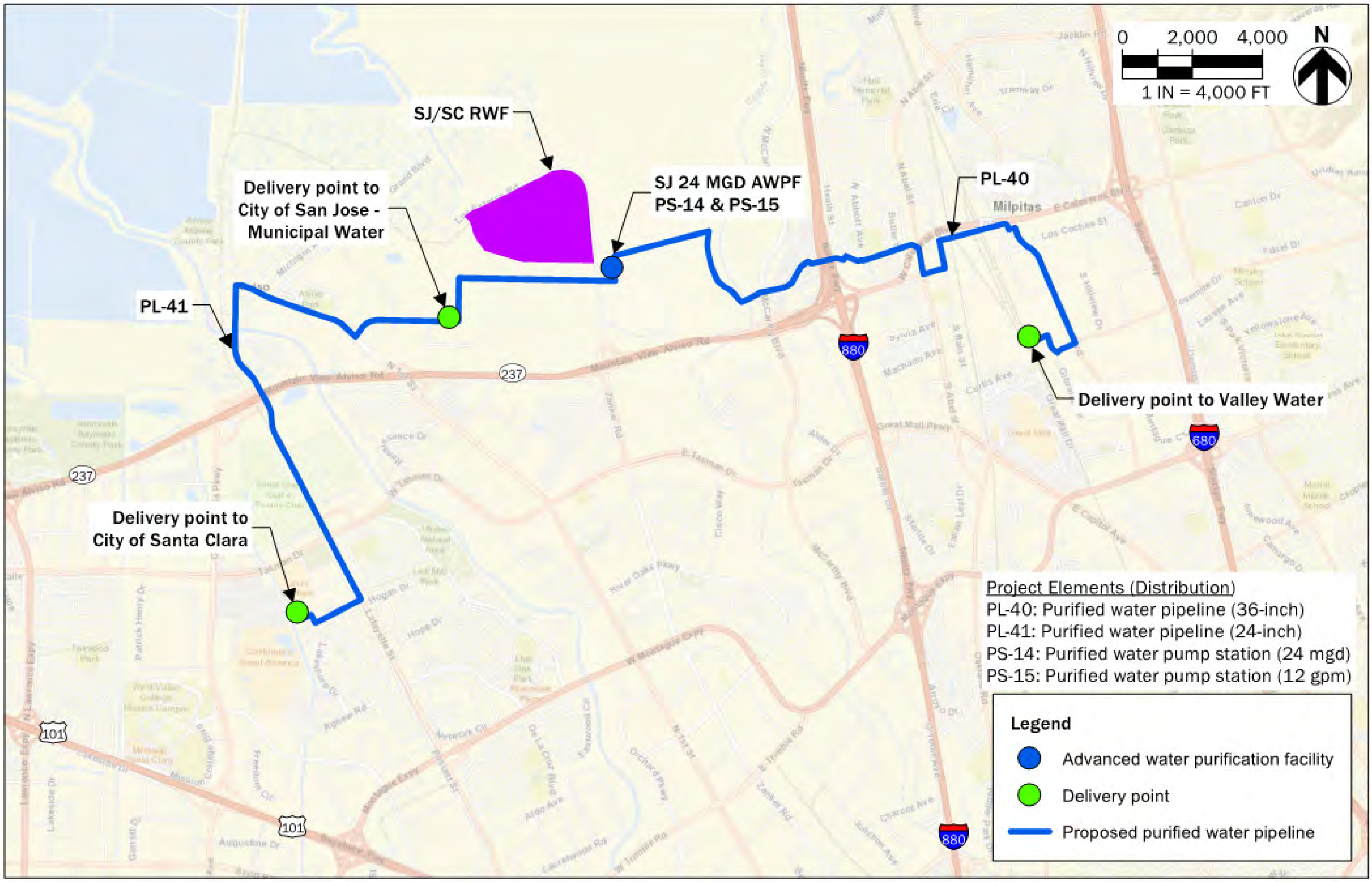
0 2,000 4,000
1 IN = 4,000 FT
N
SJ/SC RWF
Delivery point to City of San Jose - Municipal Water
SJ 24 MGD AWPF PS-14 & PS-15
PL-40
PL-41
Delivery point to Valley Water
Delivery point to City of Santa Clara
Milpitas
237
880
680
101
Project Elements (Distribution)
PL-40: Purified water pipeline (36-inch)
PL-41: Purified water pipeline (24-inch)
PS-14: Purified water pump station (24 mgd)
PS-15: Purified water pump station (12 gpm)
Legend
Advanced water purification facility
Delivery point
Proposed purified water pipeline

Figure 3-3. Portfolio 1c PR from San José AWPF for TWA

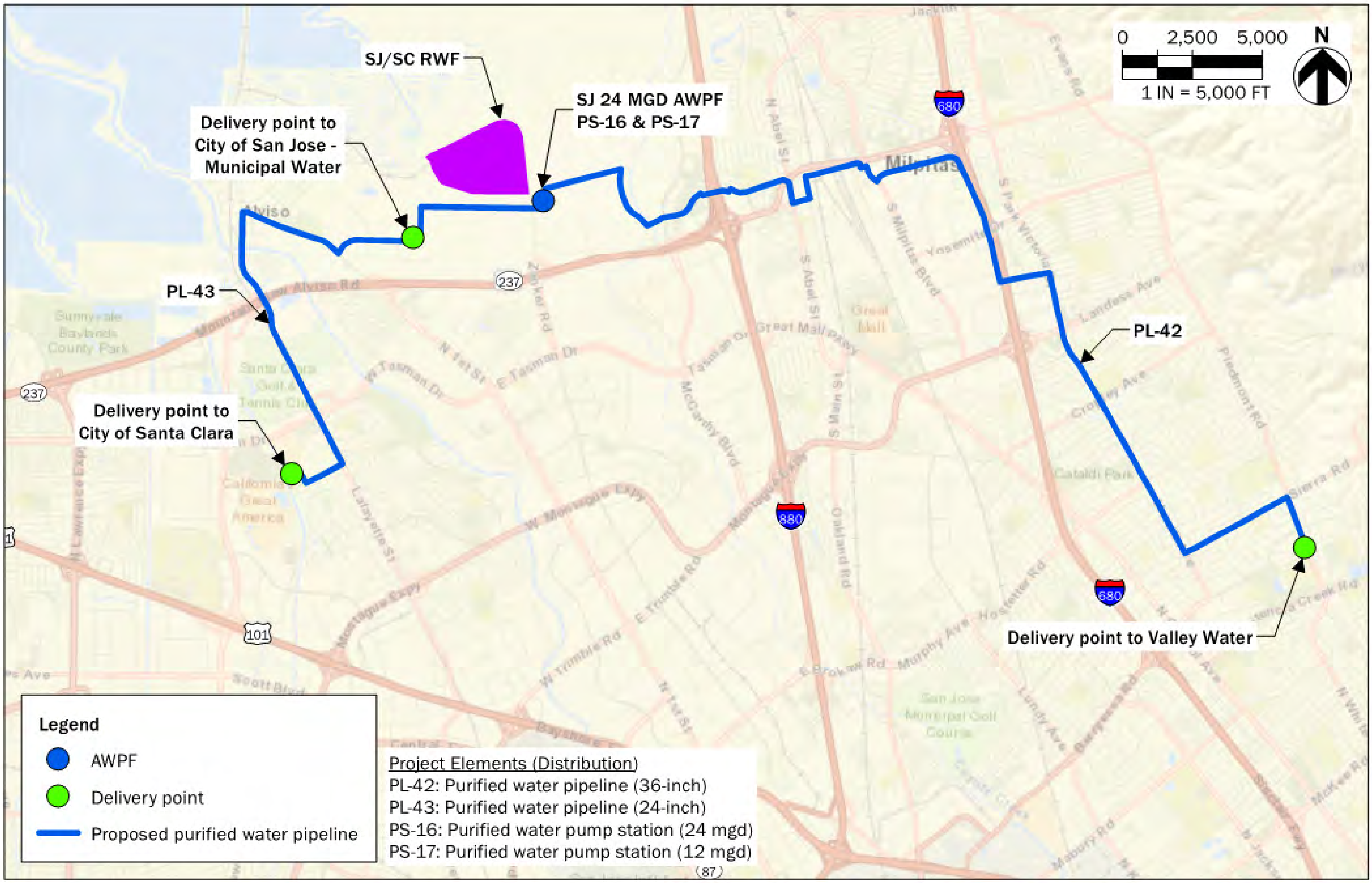
SJ/SC RWF
Delivery point to City of San Jose - Municipal Water
SJ 24 MGD AWPF PS-16 & PS-17
PL-43
PL-42
Delivery point to City of Santa Clara
Delivery point to Valley Water
Milpitas
Alviso
0 2,500 5,000
1 IN = 5,000 FT
N
Legend
AWPF
Delivery point
Proposed purified water pipeline
Project Elements (Distribution)
PL-42: Purified water pipeline (36-inch)
PL-43: Purified water pipeline (24-inch)
PS-16: Purified water pump station (24 mgd)
PS-17: Purified water pump station (12 mgd)

Figure 3-4. Portfolio 1d PR from San José AWPF for TWA

Table 3-5. Portfolio 1c Facilities Summary

Element	Criteria	Quantity	Unit	Notes
San José AWPF for TWA	Capacity	24	mgd	
Annual yield				
Annual yield	Upper bound	24,000	AFY	Based on purified water production capacity
	Lower bound	24,000	AFY	Assumes no delivery point limitations for TWA
Pump stations				
PS-14	Flow	16,700	gpm[a]	Delivery of treated water to Piedmont Valve Yard at Penitencia WTP
	TDH	350	ft	
PS-15	Flow	8,333	gpm[a]	Delivery to Santa Clara (North of Hwy 101)
	TDH	250	ft	
Effluent and purified water conveyance pipelines				
PL-1	Diameter	60	in	Effluent from SJ/SC RWF to San José AWPF
	Length	2,000	ft	
PL-40	Diameter	36	in	Purified water from San José AWPF to Gibraltar Reservoir at the Milpitas Pipeline North Terminus
	Length	3.9	miles	
PL-41	Diameter	24	in	Purified water from San José AWPF to Santa Clara (North of Hwy 101)
	Length	4.7	miles	
ROCM pipeline				
ROCM pipeline	Diameter	20	in	
	Length	9,600	ft	

a. 1 gpm = 0.00144 mgd

Table 3-6. Portfolio 1d Facilities Summary

Element	Criteria	Quantity	Unit	Notes
San José AWPF for TWA	Capacity	24	mgd	
Annual yield				
Annual yield	Upper bound	24,000	AFY	Based on purified water production capacity
	Lower bound	24,000	AFY	Assumes no delivery point limitations for TWA
Pump stations				
PS-16	Flow	16,700	gpm[a]	Purified water delivery to Piedmont Valve Yard at Penitencia WTP
	TDH	350	ft	
PS-17	Flow	8,333	gpm[a]	Purified water delivery to Santa Clara (North of Hwy 101)
	TDH	250	ft	
Effluent and conveyance pipelines				
PL-1	Diameter	60	inch	Effluent from SJ/SC RWF to San José AWPF
	Length	2,000	ft	
PL-42	Diameter	36	inch	Purified water from San José AWPF to Piedmont Valve Yard at Penitencia WTP
	Length	8.2	miles	
PL-43	Diameter	24	inch	Purified water from San José AWPF to Santa Clara (North of Hwy 101)
	Length	4.7	miles	
ROCM pipeline				
20-inch		9,600	ft	

a. 1 gpm = 0.00144 mgd

Tables 3-7 and 3-8 contain estimated capital and annual O&M costs for Portfolio 1c and 1d elements, presented in 2019 dollars, respectively.

Table 3-7. Portfolio 1c Estimated Cost Summary

Element	Capital Cost ($2019, in millions)	Annual O&M Cost ($2019, in millions)
AWPF (San José 24 mgd for TWA)	$395	$16.3
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water [PS-14]) Pump station (San José AWPF, purified water [PS-15]) Purified pipeline (San José AWPF to Gibraltar Reservoir at the Milpitas Pipeline North Terminus at Penitencia WTP) Purified pipeline (San José AWPF to Santa Clara [North of Hwy 101]) Pipeline easements	$140	$2.7
Annual Potable Reuse Supply	--	$2.4
Total, without ROCM	$535	$21.4
ROCM (existing outfall)	$20	$1.8
Total, with ROCM	$555	$23.2

All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000

Table 3-8. Portfolio 1d Estimated Cost Summary

Element	Capital Cost ($2019, in millions)	Annual O&M Cost ($2019, in millions)
AWPF (San José 24 mgd for TWA)	$395	$16.3
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water [PS-16]) Pump station (San José AWPF, purified water [PS-17]) Purified pipeline (San José AWPF Piedmont Valve Yard at Penitencia WTP) Purified pipeline (San José AWPF to Santa Clara [North of Hwy 101]) Pipeline easements	$190	$2.8
Annual Potable Reuse Supply	--	$2.4
Total, without ROCM	$585	$21.5
ROCM (existing outfall)	$20	$1.8
Total, with ROCM	$605	$23.3

All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000

3.3 Portfolio 2 - Combined Regional Palo Alto/Sunnyvale AWPF

Portfolio 2 is centered around combining available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for treatment at one AWPF that would provide regional benefit through GWR at LGRP. Source flow availability is a key consideration for a Palo Alto and Sunnyvale-based portfolio. In contrast to previous projections, influent flows have remained generally consistent over the last five years (2014 through 2018). Assuming flows remain constant through the planning horizon, available flows are expected to yield around

17,300 AFY for PR. Should influent flows increase at the rate projected in previous wastewater and recycled water planning studies, a PR project could approach a yield of 23,000 AFY.

Sourcing one AWPF from two WWTPs (operated by two separate agencies) is not common and would likely involve unique interagency and regulatory circumstances. Any compliance or reporting requirements would be doubled (e.g., both agencies would have to demonstrate that their source control programs meet the requirements). In addition, the two WWTPs contributing flow to the AWPF would need to establish a clear plan and process to coordinate operations, monitoring, and maintenance, as well as execute institutional agreements to formalize roles and responsibilities.

3.3.1 Portfolio 2a – Combined Regional AWPF in Palo Alto for GWR (LGRP)

Portfolio 2a would deliver up to 23,000 AFY from an AWPF located at the former LATP site to LGRP for GWR (Figure 3-5). There are four possible purified water alignments, though the eastern route bypassing Sunnyvale (PL-7 and PL-11) was used for estimating the portfolio cost. The LATP site is relatively small and irregularly shaped, which limits the ability to provide full perimeter access around the AWPF. With these site limitations, treatment process expansions and additions would be limited in the future. For ROCM, a pipeline would be needed to send ROC from the AWPF (located at the former LATP site) to the Palo Alto RWQCP outfall.

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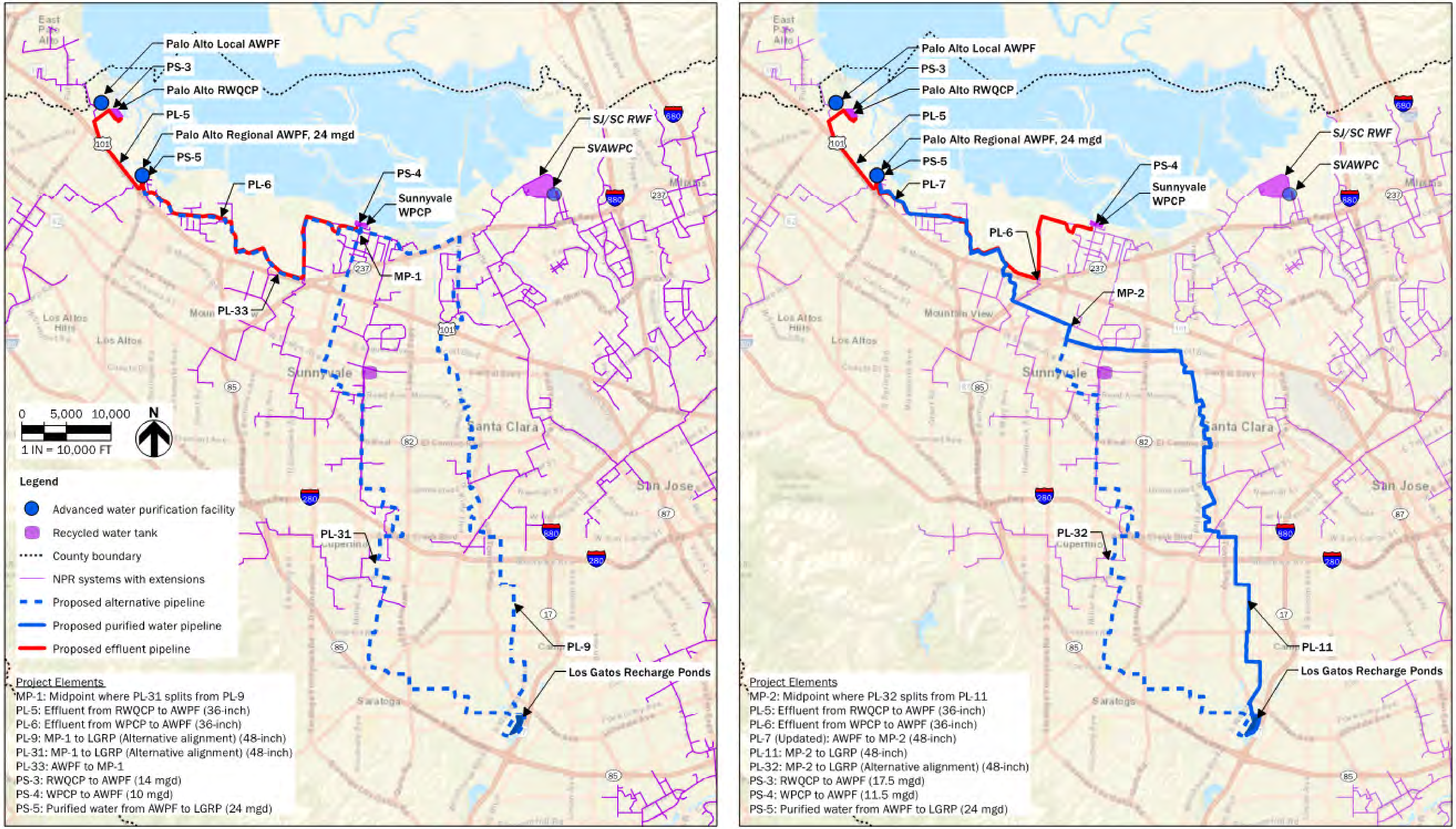
Palo Alto Local AWPF
PS-3
Palo Alto RWQCP
PL-5
Palo Alto Regional AWPF, 24 mgd
PS-5
PL-6
PS-4
Sunnyvale WPCP
MP-1
PL-33
SJ/SC RWF
SVAWPC
Sunnyvale
Santa Clara
San Jose
Los Altos Hills
Los Altos
PL-31
PL-9
Los Gatos Recharge Ponds
Saratoga
0 5,000 10,000
1 IN = 10,000 FT
N
Legend
Advanced water purification facility
Recycled water tank
County boundary
NPR systems with extensions
Proposed alternative pipeline
Proposed purified water pipeline
Proposed effluent pipeline
Project Elements
MP-1: Midpoint where PL-31 splits from PL-9
PL-5: Effluent from RWQCP to AWPF (36-inch)
PL-6: Effluent from WPCP to AWPF (36-inch)
PL-9: MP-1 to LGRP (Alternative alignment) (48-inch)
PL-31: MP-1 to LGRP (Alternative alignment) (48-inch)
PL-33: AWPF to MP-1
PS-3: RWQCP to AWPF (14 mgd)
PS-4: WPCP to AWPF (10 mgd)
PS-5: Purified water from AWPF to LGRP (24 mgd)
Palo Alto Local AWPF
PS-3
Palo Alto RWQCP
PL-5
Palo Alto Regional AWPF, 24 mgd
PS-5
PL-7
PL-6
PS-4
Sunnyvale WPCP
MP-2
SJ/SC RWF
SVAWPC
Mountain View
PL-32
PL-11
Los Gatos Recharge Ponds
Project Elements
MP-2: Midpoint where PL-32 splits from PL-11
PL-5: Effluent from RWQCP to AWPF (36-inch)
PL-6: Effluent from WPCP to AWPF (36-inch)
PL-7 (Updated): AWPF to MP-2 (48-inch)
PL-11: MP-2 to LGRP (48-inch)
PL-32: MP-2 to LGRP (Alternative alignment) (48-inch)
PS-3: RWQCP to AWPF (17.5 mgd)
PS-4: WPCP to AWPF (11.5 mgd)
PS-5: Purified water from AWPF to LGRP (24 mgd)

Figure 3-5. Portfolio 2a PR overview

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Table 3-9 summarizes Portfolio 2a facilities.

Table 3-9. Portfolio 2a Facilities Summary

Element	Criteria	Quantity	Unit	Notes
Combined regional AWPF in Palo Alto	Capacity	24.5	mgd	24 mgd for potable reuse; 0.5 mgd for NPR+ in Sunnyvale
Annual yield				
Annual yield	Upper bound	23,000	AFY	Assuming upper bound of future WWTP influent flows
	Lower bound	17,000	AFY	Assuming lower bound of future WWTP influent flows. Under these flow conditions, only an 18-mgd facility would be constructed.
Pump stations				
PS-3	Flow	12,000	gpm[a]	PA RWQCP to PA AWPF
	TDH	100	ft	
PS-4	Flow	8,000	gpm[a]	Sunnyvale WPCP to Palo Alto AWPF
	TDH	100	ft	
PS-5	Flow	16,700	gpm[a]	Delivery to LGRP
	TDH	400	ft	
Effluent and conveyance pipelines				
PL-5	Diameter	36	in	Effluent from Palo Alto RWQCP
	Length	2.9	miles	
PL-6	Diameter	36	in	Effluent from Sunnyvale WPCP
	Length	7.4	miles	
PL-7	Diameter	48	in	Purified water to LGRP
	Length	20.3	miles	
Delivery point improvements				
LGRP improvements	n/a	n/a	n/a	The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water (Valley Water, 2018a)
ROCM pipeline				
ROCM pipeline	Diameter	18	in	
	Length	10,900	ft	

a. 1 gpm = 0.00144 mgd

Table 3-10 contains estimated capital and annual O&M costs for Portfolio 2a elements, presented in 2019 dollars.

Table 3-10. Portfolio 2a Estimated Cost Summary[a]

Element	Capital Cost ($2019, in millions)	Annual O&M Cost ($2019, in millions)
AWPF (Palo Alto 24.5 mgd GWR)	$290	$13.6
Conveyance infrastructure Pump station (Palo Alto RWQCP effluent) Effluent pipeline (Palo Alto RWQCP to Palo Alto AWPF) Pump station (Sunnyvale WPCP effluent) Effluent pipeline (Sunnyvale WPCP to Palo Alto AWPF) Pump station (Palo Alto AWPF purified water) Purified pipeline (Palo Alto AWPF to LGRP) LGRP improvements Pipeline easements	$445	$3.5
Annual Potable Reuse Supply	--	$2.3
Total, without ROCM	$735	$19.4
ROCM (existing outfall)	$35	$1.6
Total, with ROCM	$770	$21.0

All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000.

3.3.2 Portfolio 2b – Sunnyvale AWPF Site for GWR (LGRP)

Portfolio 2b would deliver up to 23,000 AFY to LGRP for GWR from the AWPF located on Recycle Hill (Figure 3-6). Due to its history as a former landfill, Recycle Hill would need to be reclaimed to support locating the AWPF at this site. Refer to Appendix E-2 for the preliminary geotechnical study related to this site. Assumed costs for reclaiming Recycle Hill are based on recommendations from city of Sunnyvale staff and included in Portfolio 1b cost estimates. There are two possible routes to convey purified water from the Sunnyvale AWPF to LGRP, though the eastern route (PL-9) was selected to estimate the portfolio cost.

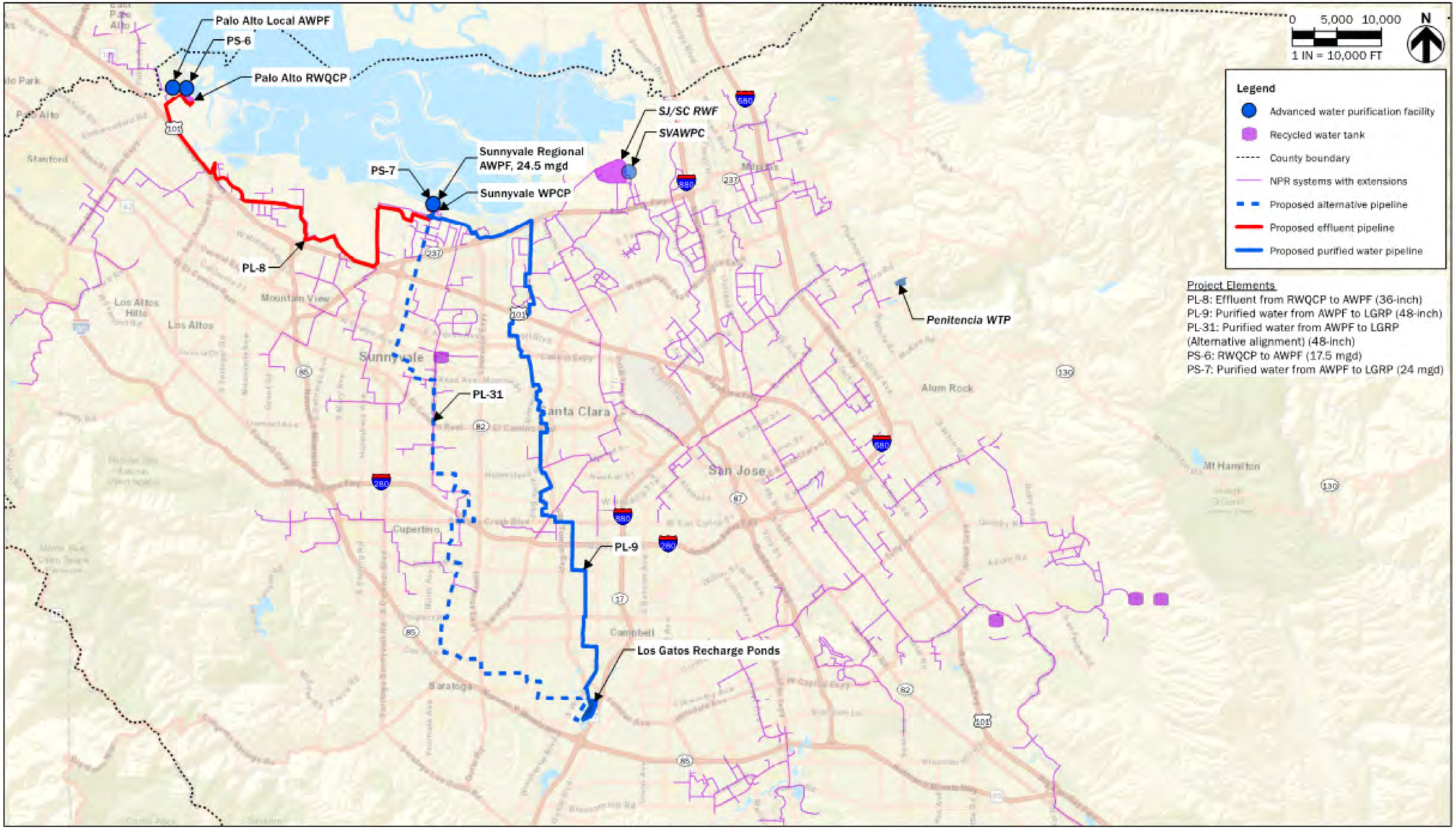
Palo Alto Local AWPF
PS-6
Palo Alto RWQCP
PS-7
Sunnyvale Regional AWPF, 24.5 mgd
Sunnyvale WPCP
SJ/SC RWF
SVAWPC
PL-8
PL-31
PL-9
Los Gatos Recharge Ponds
Penitencia WTP
0 5,000 10,000
1 IN = 10,000 FT
N
Legend
● Advanced water purification facility
Recycled water tank
----- County boundary
NPR systems with extensions
Proposed alternative pipeline
Proposed effluent pipeline
Proposed purified water pipeline
Project Elements
PL-8: Effluent from RWQCP to AWPF (36-inch)
PL-9: Purified water from AWPF to LGRP (48-inch)
PL-31: Purified water from AWPF to LGRP (Alternative alignment) (48-inch)
PS-6: RWQCP to AWPF (17.5 mgd)
PS-7: Purified water from AWPF to LGRP (24 mgd)
Palo Alto
Stanford
Mountain View
Los Altos Hills
Los Altos
Sunnyvale
Santa Clara
Cupertino
Saratoga
Campbell
San Jose
Milpitas
Alum Rock
Mt Hamilton

Figure 3-6. Portfolio 2b PR overview

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Table 3-11 summarizes Portfolio 2b facilities.

Table 3-11. Portfolio 2b Facilities Summary

Element	Criteria	Quantity	Unit	Notes
Combined regional AWPF in Sunnyvale	Capacity	24.5	mgd	24 mgd for potable reuse; 0.5 mgd for NPR+ in Sunnyvale
Annual yield				
Annual yield	Upper bound	23,000	AFY	Assuming upper bound of future WWTP influent flows
	Lower bound	17,000	AFY	Assuming lower bound of future WWTP influent flows. Under these flow conditions, only an 18-mgd facility would be constructed.
Pump stations				
PS-6	Flow	12,000	gpm[a]	Effluent from Palo Alto RWQCP to Sunnyvale AWPF
	TDH	100	ft	
PS-7	Flow	16,700	gpm[a]	Purified water delivery to LGRP
	TDH	400	ft	
Effluent and conveyance pipelines				
PL-8	Diameter	36	in	Effluent from Palo Alto RWQCP to Sunnyvale AWPF
	Length	10.0	miles	
PL-9	Diameter	48	in	
	Length	17.1	miles	
Delivery point improvements				
LGRP improvements	n/a	n/a	n/a	The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water (Valley Water, 2018a)
ROCM pipeline				
ROCM pipeline	Diameter	18	in	
	Length	32,800	ft	

a. 1 gpm = 0.00144 mgd

Table 3-12 contains estimated capital and annual O&M costs for Portfolio 2b elements, presented in 2019 dollars.

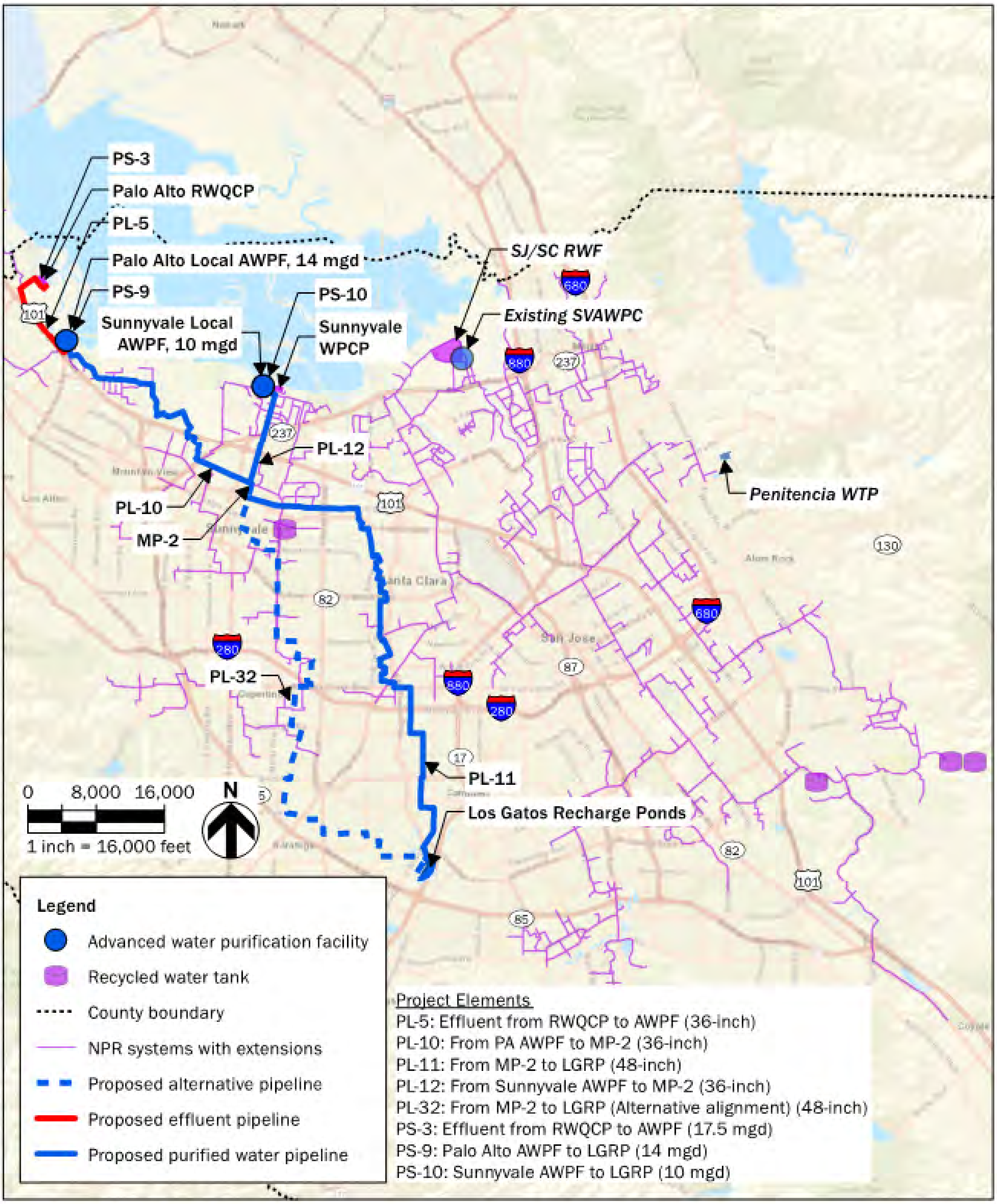
Table 3-12. Portfolio 2b Estimated Cost Summary

Element	Estimated Capital Cost ($2019, in millions)	Estimated O&M Costs ($2019, in millions)
AWPF (Sunnyvale 24.5 mgd GWR)	$350	$13.6
Conveyance infrastructure Pump station (Palo Alto RWQCP, effluent) Effluent pipeline (Palo Alto RWQCP to Sunnyvale AWPF) Pump station (Sunnyvale AWPF, purified water) Purified pipeline (Sunnyvale AWPF to LGRP) LGRP improvements Pipeline easements	$405	$2.7
Annual Potable Reuse Supply	--	$2.3
Total, without ROCM	$755	$18.6
ROCM (new outfall with enhanced mixing)	$40	$1.6
Total, with ROCM	$795	$20.2

All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000.

3.4 Portfolio 4 – Separate Palo Alto and Sunnyvale AWPFs for GWR

Portfolio 4 is centered on using available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for GWR at the LGRP. In this portfolio, two AWPFs would be constructed to use the available flow from each WWTP (Figure 3-7). The Sunnyvale AWPF would be located on Recycle Hill, and the Palo Alto facility would be on the former LATP site located in Palo Alto. Attachment B includes layouts for these facilities. Corresponding project elements include effluent conveyance pipelines, purified water conveyance pipeline from the AWPF to LGRP, infrastructure improvements to integrate purified water into LGRP, and ROCM infrastructure. There are two possible routes to convey purified water from the mid-point (Joint Purified Water Pipeline) to LGRP, though the eastern route (PL-11) was selected to estimate the portfolio cost.



Project Elements

PL-5: Effluent from RWQCP to AWPF (36-inch)
PL-10: From PA AWPF to MP-2 (36-inch)
PL-11: From MP-2 to LGRP (48-inch)
PL-12: From Sunnyvale AWPF to MP-2 (36-inch)
PL-32: From MP-2 to LGRP (Alternative alignment) (48-inch)
PS-3: Effluent from RWQCP to AWPF (17.5 mgd)
PS-9: Palo Alto AWPF to LGRP (14 mgd)
PS-10: Sunnyvale AWPF to LGRP (10 mgd)

Figure 3-7. Portfolio 4 PR overview

Available flow is a key characteristic of a Palo Alto and Sunnyvale-based portfolio. Over the last five years, influent flows have remained generally constant rather than increasing as previously projected. Similar to Portfolio 2, currently available flows would only support approximately 17,300 AFY in PR. Should influent flows increase at rates projected in prior wastewater and recycled water planning studies, a PR project could approach 23,000 AFY in the 2040 timeframe.

Table 3-13 summarizes key Portfolio 4 facilities criteria.

Table 3-13. Portfolio 4 Facilities Summary

Element	Criteria	Quantity	Unit	Notes
Separate regional AWPF (1 of 2) in Palo Alto	Capacity	14	mgd	14 mgd for potable reuse
Separate regional AWPF (2 of 2) in Sunnyvale	Capacity	10.5	mgd	10 mgd for potable reuse; 0.5 mgd for NPR+
Annual yield				
Annual yield	Upper bound	23,000	AFY	Assuming upper bound of future WWTP influent flows
	Lower bound	17,000	AFY	Assuming lower bound of future WWTP influent flows. Under these flow conditions, only an 18-mgd facility would be constructed.
Pump stations				
PS-3	Flow	12,000	gpm[a]	Effluent from Palo Alto RWQCP to Palo Alto AWPF
	TDH	100	ft	
PS-9	Flow	9,720	gpm[a]	Purified water from Palo Alto Separate AWPF to LGRP
	TDH	400	ft	
PS-10	Flow	6,950	gpm[a]	Purified water from Sunnyvale AWPF to LGRP
	TDH	400	ft	
Effluent and conveyance pipelines				
PL-5	Diameter	36	in	Effluent from Palo Alto RWQCP to Palo Alto AWPF
	Length	2.9	miles	
PL-10	Diameter	36	in	Purified water from Palo Alto AWPF to mid-point (Joint Purified Water Pipeline)
	Length	6.5	miles	
PL-11	Diameter	48		Purified water from Joint Purified Water Pipeline (at Arques) to LGRP
	Length	13.7		
PL-12	Diameter	36	in	Purified water from Sunnyvale to mid-point (Joint Purified Water Pipeline)
	Length	2.2	miles	
Delivery point improvements				
LGRP improvements [a]	n/a	n/a	n/a	The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water (Valley Water, 2018a)
ROCM pipeline				
ROCM pipeline for Palo Alto	Diameter	14	in	
	Length	10,900	ft	
ROCM pipeline for Sunnyvale	Diameter	12	in	
	Length	32,800	ft	

a. 1 gpm = 0.00144 mgd

Table 3-14 contains estimated capital and annual O&M costs for Portfolio 4 elements, presented in 2019 dollars.

Table 3-14. Portfolio 4 Estimated Cost Summary

Element	Estimated Capital Cost ($2019, in millions)	Estimated O&M Costs ($2019, in millions)
AWPF (Palo Alto 14-mgd GWR)	$195	$8.5
AWPF (Sunnyvale 10.5-mgd GWR)	$205	$6.4
Conveyance infrastructure Pump station (Palo Alto RWQCP, effluent) Effluent pipeline (Palo Alto RWQCP to Palo Alto AWPF) Pump station (Sunnyvale AWPF, purified water) Purified pipeline (Sunnyvale AWPF to Joint Purified Water Pipeline) Pump station (Palo Alto AWPF, purified water) Purified pipeline (Palo Alto AWPF to Joint Purified Water Pipeline) LGRP improvements Pipeline easements	$375	$2.9
Annual Potable Reuse Supply	--	$2.4
Total, without ROCM	$775	$20.2
ROCM (new outfall with enhanced mixing)	$60	$1.7
Total, with ROCM	$835	$21.9

All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000.

3.5 South County Reuse Options

To explore solutions to augment Morgan Hill's overall supply, the Project Team reviewed previous South County reuse work and developed new conceptual alternatives for consideration.

The 2015 South County RWMP Update, used as the primary reference source, evaluated water reuse alternatives for South County, including supplying recycled water from the SCRWA WWTP to Morgan Hill—an option determined to require a new transmission main of about 10 miles and substantial energy to convey water north from an elevation of about 155 feet at SCRWA to Morgan Hill-area customers at elevations between 345 to 400 feet.

The 2015 South County RWMP identified a preferred option involving expanding NPR near the SCRWA plant and the existing recycled water distribution system in Gilroy. However, as the plan acknowledged, the SCRWA facility is challenged in meeting existing maximum day NPR demand (5.2 mgd in 2014) and reuses most of the average dry weather influent flow (6.0 mgd in 2014).

Morgan Hill has indicated a desire to be supplied recycled water consistent with Options MH-6 and MH-7 as described in the 2015 South County RWMP, which would serve 36 customers including schools, parks, and the Institute Golf Course (Figure 3-8).

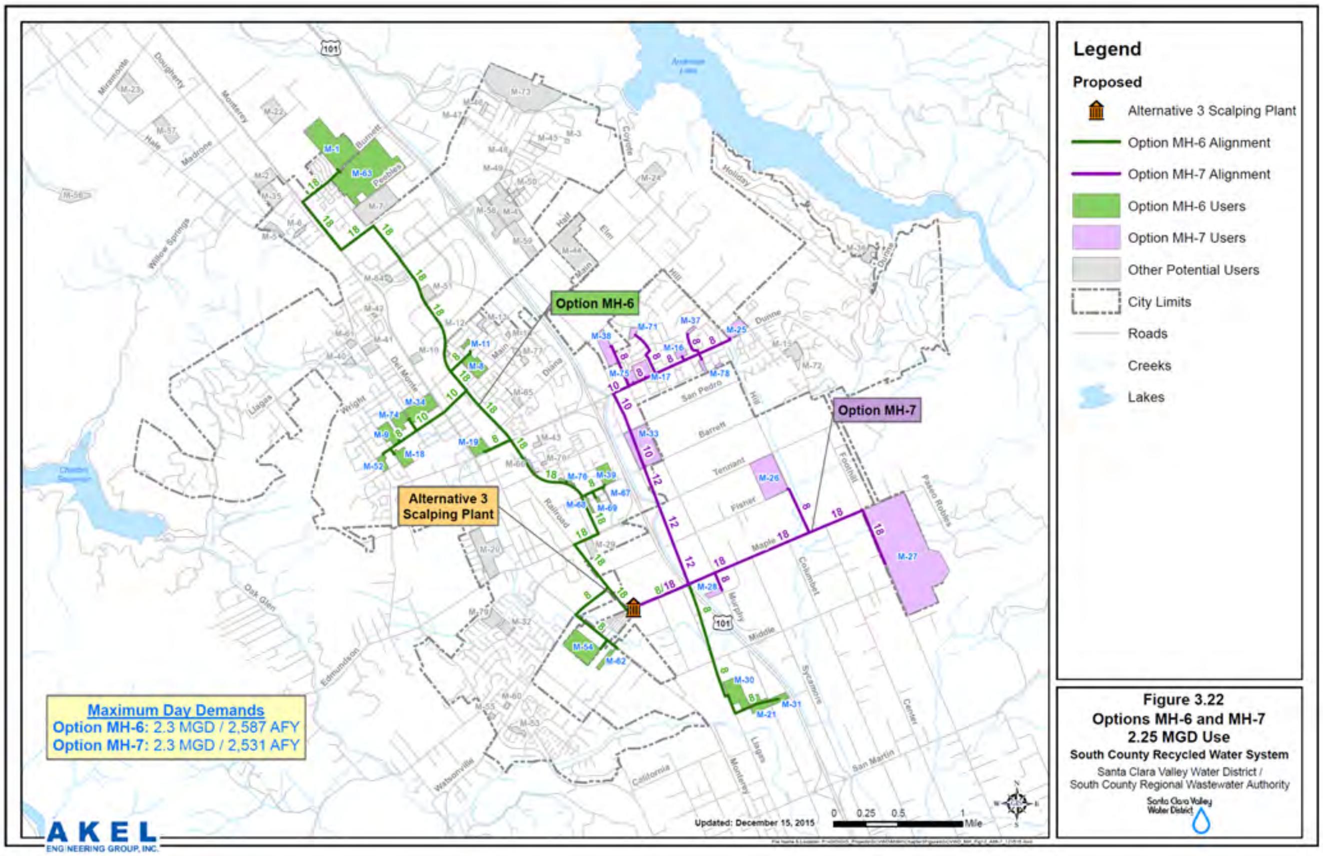


Figure 3-8. Morgan Hill potential NPR distribution system

Source: SCRWA, 2016. (2015 South County Recycled Water Master Plan Update)

The Countywide Master Plan is exploring several new project concepts. A new NPR+ concept would involve service from the SBWR system using a new 18-inch pipeline extension. The pipeline would be located on Monterey Road beginning at the current SBWR terminus near Blanchard Road and Metcalf Energy Center (elevation of 255 feet) and continuing about 6 miles to Burnett Road in Morgan Hill (Figure 3-9). At Burnett Road, the pipeline extension from SBWR would connect into the northern terminus of the Morgan Hill NPR distribution system (MH-6 alignment as presented in the 2015 South County RWMP Update). Morgan Hill's distribution network is estimated at 16.3 miles of pipelines with elevations ranging between approximately 345 to 400 feet. The transmission line could serve peak demands of up to 5 mgd to Morgan Hill, meeting an annualized NPR demand of 2,900 AFY.

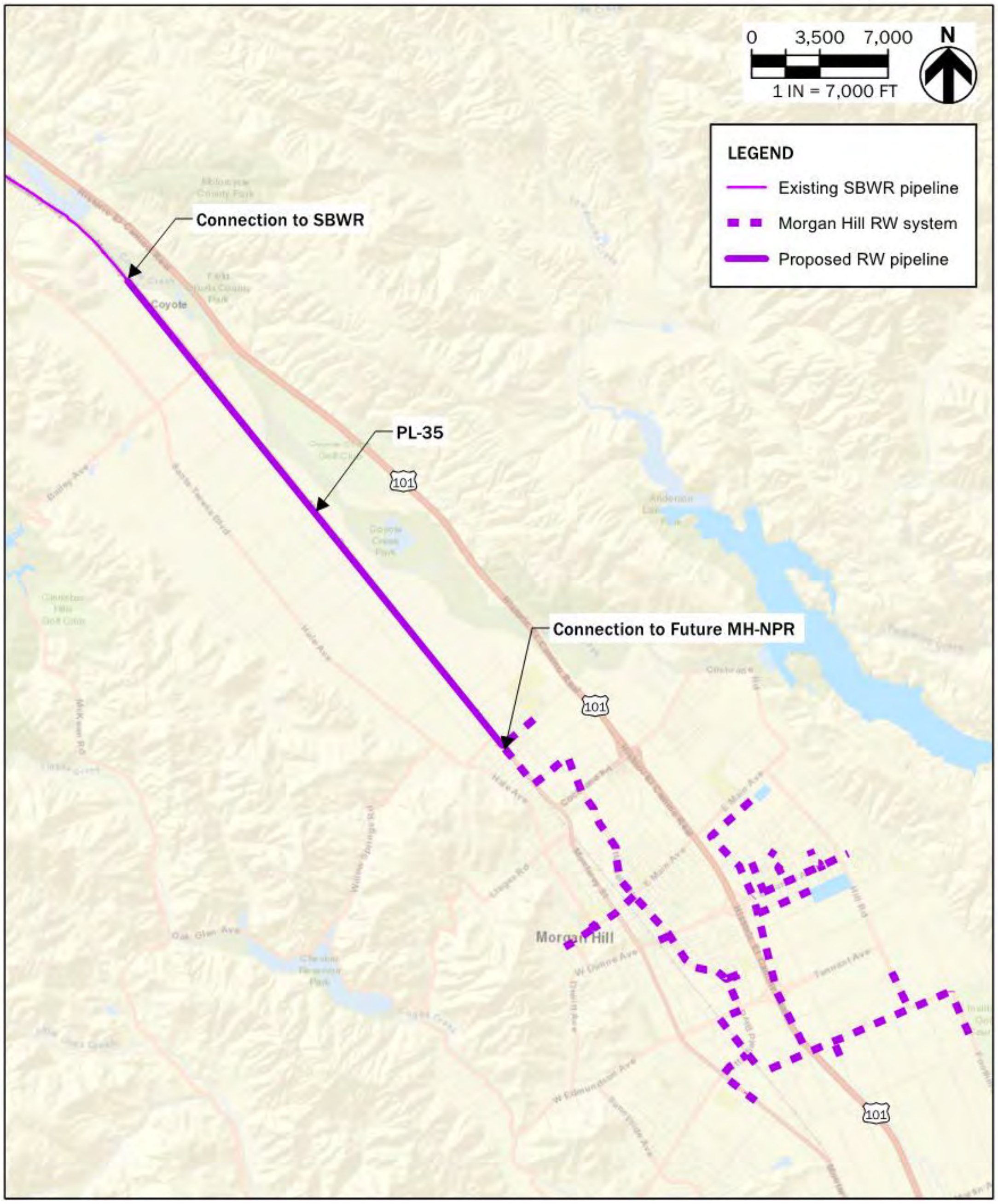


Figure 3-9. Transmission line from SBWR to Morgan Hill for NPR+ distribution

Source for Morgan Hill NPR distribution system: SCRWA (2016)

In addition, two conceptual IPR alternatives were evaluated—GWR and SWA from a satellite WWTF, and AWPF. Locations for both the satellite treatment facility and recharge ponds are challenges that have kept these options conceptual in nature. For the purpose of preliminary design and cost assessments, the GWR alternative assumes the treatment facility would be located at the site identified for a satellite treatment plant in the 2014 South County RWMP, and a transmission pipeline would convey purified water to the existing San Pedro recharge ponds as the delivery point (Figure 3-10). Due to the significant number of potable wells in the service area, travel time in the groundwater basin is assumed to be two months for planning purposes.

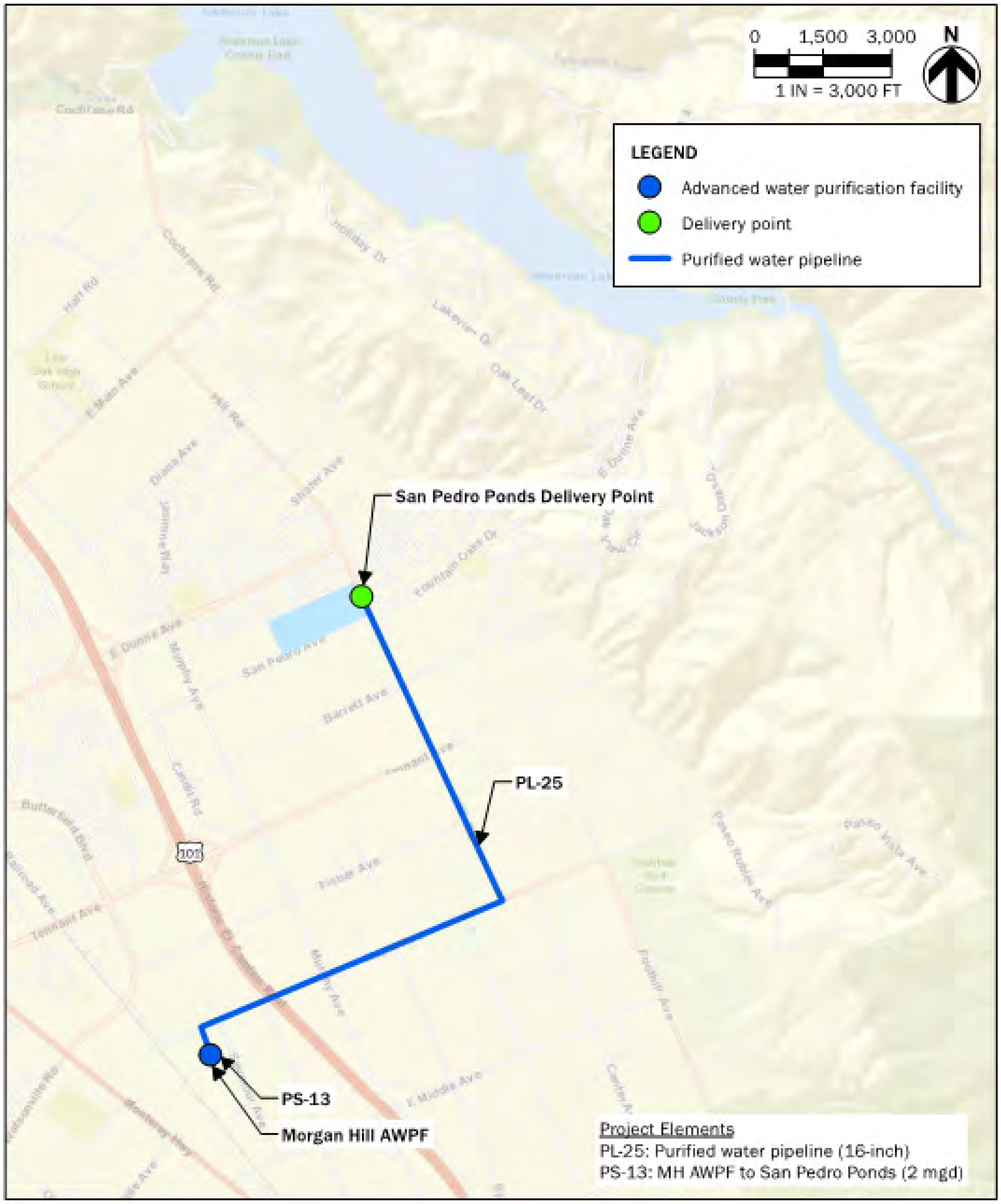


Figure 3-10. Transmission line from proposed Morgan Hill AWPF to San Pedro Recharge Ponds

The SWA variation assumes a transmission pipeline would convey purified water from the AWPF to the south end of Anderson Reservoir (Figure 3-11). Using an assumed alignment on East Duane Avenue, the pipeline would traverse up to an elevation (ground) of approximately 880 feet, which would result in a static lift of about 560 feet. While a detailed analysis has not been performed as part of this conceptual evaluation, dilution and detention time are assumed to be significant for a 2.1-mgd SWA project, considering Anderson's total capacity of more than 89,000 AF. Consistent with current operations, Valley Water will treat the blended supply from Anderson Reservoir at Santa Teresa WTP or Rinconada WTP. Thus, purified water supplied to Anderson Reservoir would generally be used north of Morgan Hill. In exchange for contributing supply to Anderson Reservoir, Valley Water would increase deliveries from the Santa Clara Conduit to existing percolation ponds to recharge Morgan Hill's groundwater basin.

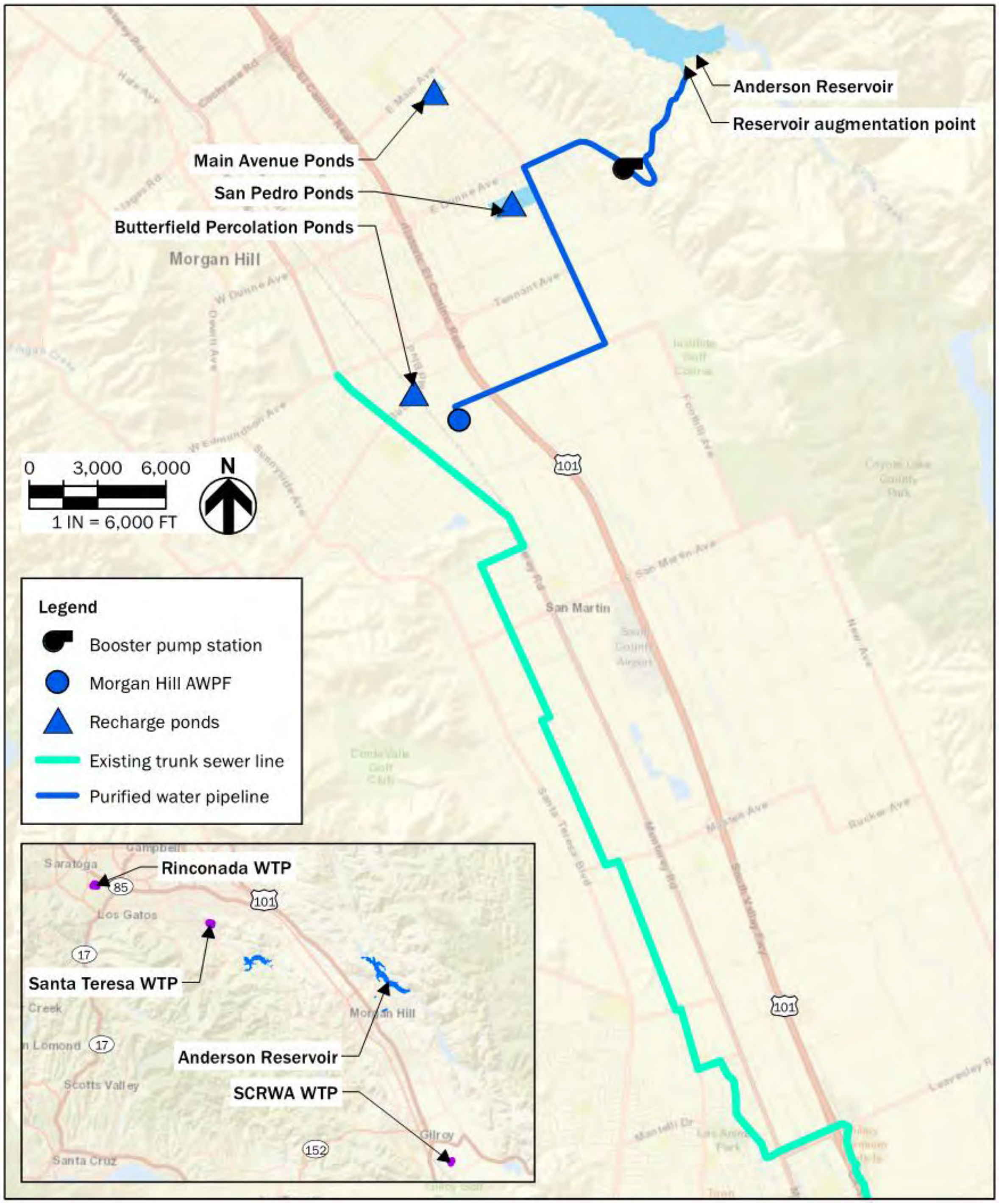


Figure 3-11. Transmission line from proposed Morgan Hill AWPF to Anderson Reservoir

For the IPR alternatives, a FAT train is assumed and requires an ROCM solution. Valley Water's ROCM team reports that the Morgan Hill AWPF would require 80 to 100 acres of lined evaporation ponds as the best option for managing ROC. Due to limited land availability in Morgan Hill, ponds are assumed to be located near the SCRWA facility in Gilroy and would require construction of a 59,000 feet of 8-inch pipeline to convey ROC from the Morgan Hill AWPF to Gilroy.

A challenge with Morgan Hill IPR is that diverting flow from the trunk sewer reduces flow at the SCRWA plant, which currently uses much of the available effluent for NPR in Gilroy, particularly during the summer months. In addition, the SCRWA partners, including Morgan Hill, have recently decided to move forward with expanding the SCRWA treatment plant for future wastewater treatment. Should a satellite WWTP facility also be developed, the region may end up with underutilized assets (i.e., unused WWTP capacity) and other unanticipated collection system issues due to reduced wastewater flows.

Table 3-15 summarizes the Morgan Hill alternatives considered.

Table 3-15. Morgan Hill Alternatives Comparison Summary

Item	Reference point: NPR from SCRWA [a]	Option 1: NPR+ from SBWR [b,c]	Option 2: Satellite AWPF for GWR	Option 3: Satellite AWPF for SWA
Annual yield (AFY)	785	2,900	2,350	2,350
Transmission pipeline length (miles)	9.0	6.0	2.8	5.9
NPR distribution pipelines length (miles)	9.6	16.3	--	--
Max elevation gain along pipelines (feet)	190 to 245	90 to 145	~48	~560
Capital ($2019 in millions)				
Treatment	--	--	$60	$60
Conveyance infrastructure, including pipeline easements	$40	$30	$15	$35
NPR distribution infrastructure	$20	$40	--	--
ROC management	--	--	$50[d]	$50[d]
Well relocation (~31 wells)	--	--	TBD	--
Total capital cost	$60	$70	$125	$145
Annual O&M ($2019 in millions)				
Treatment	--	--	$6.7	$6.7
Transmission infrastructure	$1.2	$0.1	$0.1	$0.6
NPR distribution infrastructure	$0.7	$0.7	--	--
Source water cost	--	$1.8[c]	--	--
ROC management	--	--	$0.1	$0.1
Total O&M cost	$1.9	$2.6	$6.9	$7.4

a. Based on costs presented in the 2015 South County RWMP Update.

b. Long-term recycled water supply from the SBWR system would require an institutional agreement with the City of San José. In addition, numerous opportunities for recycled water expansion in the north portion of the County may limit recycled water availability. Annual yield is based on Morgan Hill's conceptual buildout demand from the 2015 South County Recycled Water Master Plan Update, assuming sufficient NPR supply from SBWR to meet demand.

c. Assuming $600/AF.

d. Estimated ROC management cost does not include the cost of land for evaporation ponds. All ROC management costs are subject to change.

Before implementing any of the South County reuse options, the following issues need to be reviewed and confirmed:

- **Appropriate sizing to avoid impacts to the sewage collection system during times of minimum flows.** Solids resulting from MBR treatment at a Morgan Hill satellite WWTP are assumed to discharge into the trunk line for treatment at SCRWA's WWTP. Further design consideration is needed to avoid potential creation of odor and clogging problems in the existing collection system.

- **Process performance issues at the SCRWA WWTP due to influent composition changes.** Decreased flow from Morgan Hill with more concentrated solids content would create operational and process performance issues at the WWTP with inconsistent sludge wasting and reduced BOD loadings. WWTP improvements to address these potential issues are currently not included in the costs presented in the Countywide Master Plan and would need to be considered and confirmed before implementing this project.
- **Ability to meet current South County RWS demands for recycled water.** Reduced inflows to SCRWA's WWTP could result in the inability to meeting current recycled water demands at times of critical and peak demand.

3.6 Future Opportunities and Alternative Elements

Several potential project elements discussed in Section 2 are not considered baseline components of any portfolio but may be included through either a substitution (e.g., an alternate pipeline alignment) or "add-on" (e.g., new interties between systems). These alternative project elements are summarized below.

3.6.1 Potential Future NPR Projects

AWPF for NPR+ in Sunnyvale. Sunnyvale does not have a need for NPR+ in its service area; however, if there is reason to connect to either PA/MV and/or SBWR NPR+ systems, Sunnyvale may consider an AWPF to provide water quality consistent with SBWR and PA/MV systems.

Additional AWPF in San José for NPR+. Sometimes referred to as an "SVAWPC extension," an additional AWPF may be considered in San José to increase purified water production capacity for NPR+ to maintain a TDS level of 500 mg/L year-round.

3.6.2 System Interties

The following interties were considered as project elements but not included in any portfolio. One or more interties may be added later if a need arises.

Sunnyvale-SBWR interties. Three interties between Sunnyvale and SBWR were considered, including an effluent intertie to convey secondary effluent from Sunnyvale WPCP to the SJ/SC RWF or SVAWPC and two recycled water interties (one northern and one southern connector).

Sunnyvale-PA/MV intertie. An intertie could connect an existing 16-inch pipeline on Enterprise Way in Sunnyvale to a new 16-inch recycled water pipeline located in Moffett Field.

Connecting Sunnyvale's recycled water distribution system to the SBWR or PA/MV system would require an AWPF for NPR+ in Sunnyvale for equivalent water quality.

3.6.3 Alternative PR Alignments

Multiple route variations were considered for conveying purified water from a new AWPF in Palo Alto and/or Sunnyvale to LGRP for GWR. One default alignment was selected for the purpose of determining costs and relative pipe lengths across portfolios, though other alignments also offer potential advantages. For example, the default alignment for Portfolio 2a (PL-7 and PL-11) is the shortest alignment and bypasses Sunnyvale. If, however, there is potential to also convey water to LGRP from a San José AWPF in the future, using the Expedited Purified Water Program alignment (PL-9) may be advantageous due its proximity to the SJ/SC RWF.

Table 3-16 summarizes the default and alternative pipeline alignments for Portfolios 2a, 2b, and 4, and includes relative capital costs. More detailed costs are presented in Appendix 6.

Table 3-16. Summary of Purified Water Pipeline Alignments by Portfolio

	Default Alignment			Alternate Alignment(s)		
Portfolio(s)	Pipeline Number	Description	Capital cost ($2019, in millions)[a]	Pipeline Number	Description	Capital Cost ($2019, in millions)[a]
Portfolio 2a Combined Regional AWPF in Palo Alto for GWR	PL-7 PL-11	Eastern route, bypassing Sunnyvale (PL-7 is from AWPF to MP-2; PL-11 is from MP-2 to LGRP)	$96 $189	PL-33 & PL-9	Eastern route, via Sunnyvale WPCP	$330
				PL-33 & PL-31	Western route, via Sunnyvale WPCP	$330
				PL – 32 (alternative for PL-11)	Western route, bypassing Sunnyvale (from MP-2 to LGRP)	$210
Portfolio 2b Sunnyvale AWPF Site for GWR	PL-9	Eastern route, Sunnyvale AWPF to LGRP	$250	PL-31	Western route, Sunnyvale AWPF to LGRP	$255
Portfolio 4 Separate Palo Alto and Sunnyvale AWPFs for GWR	PL-10	From Palo Alto AWPF to Joint Purified Water Pipeline	$70			
	PL-12	From Sunnyvale AWPF to Joint Purified Water Pipeline	$25	PL-32 (alternative for PL-11)	Western route from Joint Purified Water Pipeline to LGRP	$210
	PL-11	Eastern route from Joint Purified Water Pipeline (with Sunnyvale AWPF product water) to LGRP	$190			

a. *All capital costs are rounded up to the nearest $5 million.*

3.6.4 Potential Future PR Projects

Pipeline extension from LGRP to Rinconada WTP for RWA. As discussed in Section 2.1.2.4, there is potential to build a new pipeline and pump station from LGRP to Rinconada WTP to increase operational flexibility of options involving GWR. This RWA variation would improve potable reuse supply yield at times when the groundwater basin is filled to capacity and recharge is not possible. Preliminary estimates indicate capital costs for the pipeline would be approximately $25 million, with $20,000 in annual O&M costs.

West County TWA. Portfolios 1c and 1d explore using SJ/SC RWF source water for TWA because that allows for a case study that presents the full range of potable reuse options. However, there are opportunities for TWA throughout the county, including one that Valley Water is already considering and involves extending the West Pipeline. The West County TWA Scenario would deliver up to 24,000 AFY of purified water. Like Portfolio 2a, effluent would be conveyed from the PA RWQCP and Sunnyvale WPCP to a 24-mgd AWPF that would be constructed at the former Los Altos WWTP site.

From the AWPF, a pump station sized to convey 24 mgd at a TDH of ~500 ft would pump purified water from the PA AWPF to the West Pipeline. Local turnouts from this pipeline would be constructed to use purified water locally in Palo Alto and Mountain View during years where supplemental water supplies are required. The remainder of the purified water would be transported through the West Pipeline, where it would be blended with treated water and delivered through existing turnouts to customers along that pipeline.

Conveyance from the AWPF to the West Pipeline at Stevens Creek Blvd would require an 11 mile, 36-inch pipeline (shown in Figure 3-12). The pipeline route was selected to minimize traffic impacts, minimize easement requirement, and facilitate construction. Specifically, the route avoids longitudinal encroachments along both El Camino Real and Foothill Expressway, and is located to facilitate trenchless crossings of both Highway 101 and Interstate 280. Both the base and alternate alignments cross Interstate 280, but the base alignment is located under high voltage electrical transmission towers.

Table 3-17 summarizes the West County TWA scenario facilities. Table 3-18 contains estimated capital and annual O&M costs for the West County TWA scenario elements, presented in 2019 dollars.

Table 3-17. West County TWA Scenario Facilities Summary

Element	Criteria	Quantity	Unit	Notes
Combined regional AWPF in Palo Alto	Capacity	24	mgd	24 mgd for potable reuse
Annual yield				
Annual yield	Upper bound	17,300	AFY	Under current flows, only an 18-mgd facility would be implemented
	Lower bound	23,000	AFY	
Pump stations				
PS-3	Flow	12,000	gpm[a]	Effluent from PA RWQCP to Sunnyvale AWPF
	TDH	100	ft	
PS-4	Flow	8,000	gpm[a]	Effluent from Sunnyvale WPCP to Sunnyvale AWPF
	TDH	100	ft	
PS-18	Flow	16,700	gpm[a]	Delivery of treated water to West Pipeline at Stevens Creek Blvd
	TDH	500	ft	
Effluent and conveyance pipelines				
PL-5	Diameter	36	in	Effluent from Palo Alto RWQCP
	Length	2.9	miles	
PL-6	Diameter	36	in	Effluent from Sunnyvale WPCP
	Length	7.4	miles	
PL-44	Diameter	36	in	Purified water to West Pipeline at Stevens Creek Blvd
	Length	10.7	miles	
ROCM pipeline				
ROCM pipeline	Diameter	18	in	
	Length	10,900	ft	

a. 1 gpm = 0.00144 mgd

Table 3-18. West County TWA Scenario Estimated Cost Summary		
Element	Estimated Capital Cost ($2019, in millions)	Estimated O&M Costs ($2019, in millions)
AWPF (Palo Alto 24 mgd for TWA)	$320	$16.1
Conveyance infrastructure Pump station (Palo Alto RWQCP, effluent) Pump station (Sunnyvale WPCP, effluent) Effluent pipeline (Palo Alto RWQCP to Sunnyvale AWPF) Effluent pipeline (Sunnyvale WPCP to Sunnyvale AWPF) Pump station (Sunnyvale AWPF, purified water) Purified pipeline (Sunnyvale AWPF to West Pipeline) Pipeline easements	$255	$2.6
Annual Potable Reuse Supply	--	$2.4
Total, without ROCM	$575	$21.1
ROCM (existing outfall)	$35	$1.6
Total, with ROCM	$610	$22.7

All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000.

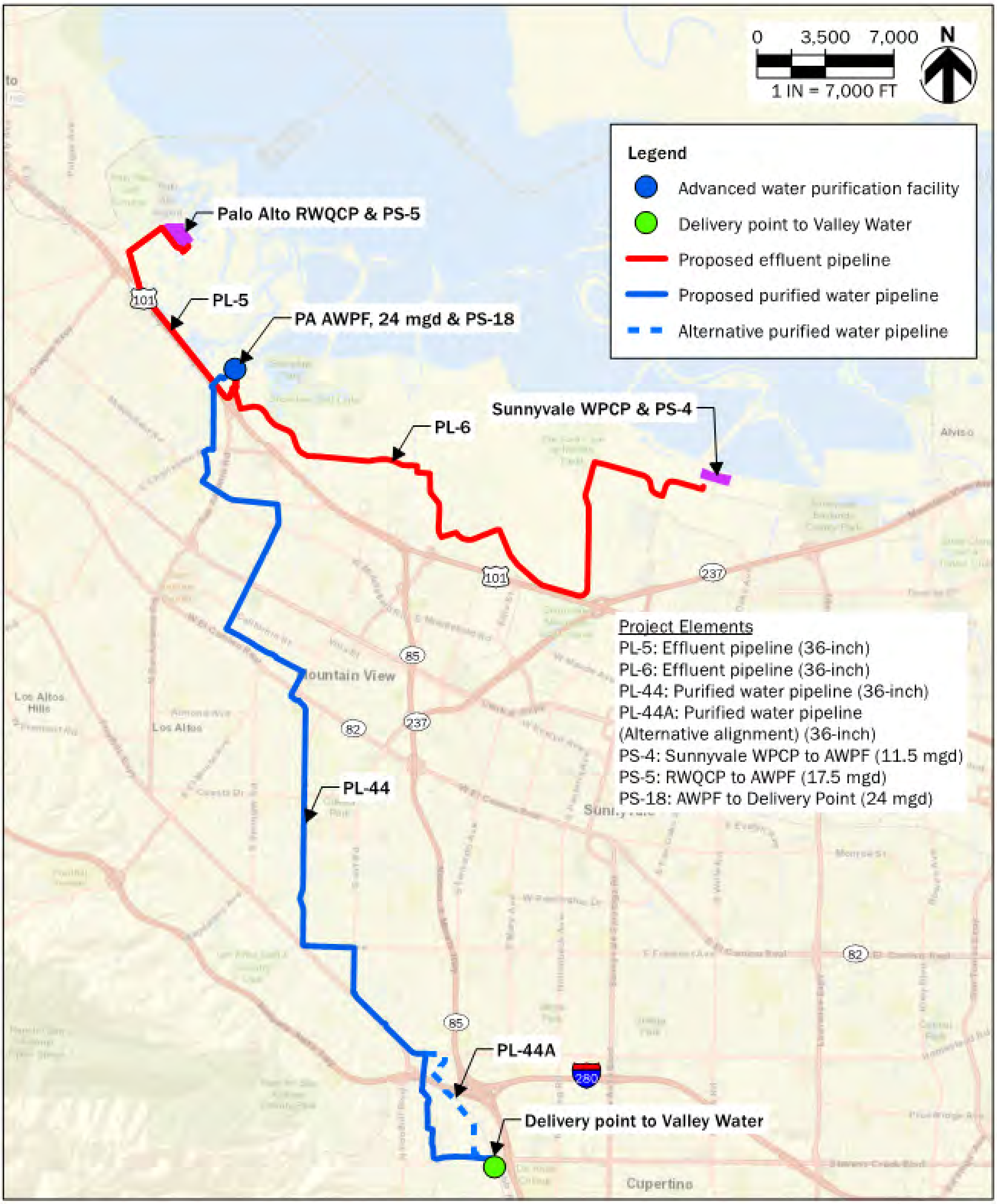

0
3,500
7,000
N
1 IN = 7,000 FT
Legend
● Advanced water purification facility
● Delivery point to Valley Water
Proposed effluent pipeline
Proposed purified water pipeline
Alternative purified water pipeline
Palo Alto RWQCP & PS-5
PL-5
PA AWPF, 24 mgd & PS-18
Sunnyvale WPCP & PS-4
PL-6
Project Elements
PL-5: Effluent pipeline (36-inch)
PL-6: Effluent pipeline (36-inch)
PL-44: Purified water pipeline (36-inch)
PL-44A: Purified water pipeline
(Alternative alignment) (36-inch)
PS-4: Sunnyvale WPCP to AWPF (11.5 mgd)
PS-5: RWQCP to AWPF (17.5 mgd)
PS-18: AWPF to Delivery Point (24 mgd)
PL-44
PL-44A
Delivery point to Valley Water
101
237
85
82
280
Mountain View
Los Altos Hills
Los Altos
Alviso
Cupertino

Figure 3-12. West County TWA overview

South County TWA. Two potential South County TWA options have been discussed with staff from Morgan Hill and Gilroy. The first TWA option would use water treated at a satellite WWTF and AWPF in Morgan Hill and then delivered to the Morgan Hill drinking water distribution system. It is likely this option would have a high life-cycle unit cost given the high level of treatment, lack of ROC management options, and limited yield. A second TWA option would use water treated at a new AWPF adjacent to SCRWA in Gilroy and deliver purified water to the Gilroy drinking water distribution system. This option would likely have similar limitations as the first South County TWA option and limit supply available for NPR use in Gilroy.

3.7 ROC Management Cost Summary

Valley Water's ROC Management Team is separately developing ROC management strategies, and findings from their work, including costs, will be integrated into the Final Master Plan.

Section 4: Economic Assessment

The economic assessment of the feasible portfolios consists of cost estimates and a life-cycle evaluation capturing the full economic cost over a period of 30 and 100 years.

Two attachments are essential complements to the economic assessment:

- Attachment C: Basis of Cost, which documents inputs, assumptions, methods, and sources.
- Attachment D: Detailed Cost Estimates, which provide line-item costs for the AWPFs, pump stations, pipelines, interties, recharge ponds, and water supply source costs.

4.1 Life-Cycle Evaluation

The cost estimates summarized in Section 3 and provided in detail in Attachment D form the basis of the life-cycle cost assessment. A life-cycle evaluation captures the full estimated present value cost to construct, implement, operate, and maintain a facility over a set period of time. One important element is incorporation of rates for both inflation and discounting. The inflation rate accounts for increases in price and decreases in purchasing value. The discount rate accounts for the time value of money and affects net present value (NPV) for projects with a significant difference between timing of benefits and costs (e.g., an initial investment followed by delayed benefits).

For its master plans, Valley Water uses a 30-year and 100-year life-cycle cost evaluation to compare and evaluate water supply alternatives, as described in detail in Appendix B of the WSMP 2040 (Valley Water, 2019b). The life-cycle evaluation evaluates the total cost and dollars per AF of each portfolio over a 30-year and 100-year life-cycle span. Costs consist of capital for AWPFs, pump stations, and pipelines; replacement and renewal (R&R) of major equipment; ROC Management; and O&M of new baseline project elements (i.e., consumable items related to treatment facilities, pump stations, pipelines, and water supplies). Table 4-1 identifies those costs that are included in the 30-year and 100-year life-cycle evaluations.

Table 4-1. Costs Included in Life-Cycle Comparisons

Project Element	Description
Morgan Hill Option 1: NPR+[a]	Transmission pipeline from SBWR and distribution system to deliver NPR+ to Morgan Hill customers; source water cost
Morgan Hill Option 2: GWR[a]	Satellite plant in Morgan Hill with purified water pumped and piped from AWPF to San Pedro Recharge Ponds; ROC Management; and PR source water cost
Morgan Hill Option 3: SWA[a]	Satellite plant in Morgan Hill with purified water pumped and piped from AWPF to Anderson Reservoir; ROC Management; and PR source water cost
Portfolio 1a	San José AWPF for GWR at LGRP; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 1b	San José AWPF for RAW at Penitencia WTP; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 1c	San José AWPF for TWA to Milpitas pipeline and North Santa Clara and San José; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 1d	San José AWPF for TWA to Piedmont Valve Yard and North Santa Clara and San José; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 2a	Combined regional AWPF in Palo Alto for GWR at LGRP; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 2b	Combined supply to Sunnyvale AWPF for GWR at LGRP; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 4	Separate Palo Alto and Sunnyvale AWPFs for GWR at LGRP; conveyance infrastructure; ROC Management; and PR source water cost

a. The Morgan Hill PR options do not satisfy Valley Water's goal of reaching 24,000 AF but are important potential projects that may accompany any of the North County portfolios.

The following alternative elements were discussed in Section 2 and 3, though not considered in the life-cycle cost evaluations:

- NPR/NPR+ expansion projects, including treatment facilities (e.g., Sunnyvale AWPF for NPR+ and San José AWPF for expanded NPR+)
- Recycled water system interties
- Pipeline extension from LGRP to Rinconada WTP
- Alternative alignments from Palo Alto and/or Sunnyvale to LGRP (i.e., those shown in Section 2 and not reflected in Section 3 figures)

The life-cycle evaluation calculates present value costs. Present value costs convert future payments (e.g., costs that will need to be paid in 10 or 50 years) to today's dollars. It takes into consideration a fundamental principle of business finance: the time value of money, in which one dollar today has greater value than one dollar in the future. The time value of money is affected by inflation (i.e., decreasing purchasing power) and opportunity cost (i.e., foregoing money that could have been invested with compound interest to gain more money). The present value cost analysis evaluates future potential spend over a fixed period while controlling for inflation (3 percent per year) and for the discount rate (5.5 percent per year), which adjusts future cash flows to the present day.

Table 4-2 defines key concepts for the economic comparison of life cycles.

Table 4-2. References for Economic Comparison of Life Cycles

Term	Description
Estimated capital	Estimated nominal (not accounting for inflation or discounting) capital costs for the entire life cycle, represented in August 2019 dollars
Estimated O&M	Estimated nominal (not accounting for inflation or discounting) O&M costs (e.g., energy, chemical, labor) for the entire life cycle, represented in August 2019 dollars Source water supply costs ($2.5M/year per portfolio) are included in this estimate. (Source water costs may be revisited pending agreements with publicly owned treatment facilities.)
Estimated R&R	Estimated nominal (not accounting for inflation or discounting) costs for R&R of major equipment, represented in August 2019 dollars
Total cost	Sum of estimated nominal (not accounting for inflation or discounting) capital, O&M, and R&R costs, represented in August 2019 dollars
Total cost, present value	Current value of estimated capital, O&M, and R&R costs that will be incurred over the project lifespan. Present value costs reflect Valley Water's real discount rate (2.43%; costs inflated at 3% and then discounted back to current dollars at 5.5%), represented in 2019 dollars. Real discount rate is consistent with Valley Water's unit cost of water methodology, as also used in the Expedited Purified Water Program Plan. Assumes construction begins in 2024 and operations begin in 2028
Total yield	Average water supply system yield, represented in thousand acre-feet (TAF) Assumes long-term annual yield per portfolio is 18,500 AFY (based on WEAP modeling of GWR and RWA alternatives performed for the Expedited Purified Water Program Plan. Yield from TWA has not yet been evaluated).
Present value yield	Per Valley Water's unit life-cycle approach, water supply system yields are discounted at the real discount rate (2.43%; costs inflated at 3% and then discounted back to current dollars at 5.5%), represented in AF
Life-cycle unit cost	Present value cost divided by the present value yield, represented in $/AF

Tables 4-3 and 4-4 contain estimated nominal costs and present value costs (represented in 2019 dollars), water supply system yields (represented in AF), and life-cycle unit costs (represented in $/AF) for the 30-year life cycles for each South County reuse option and North County portfolio, respectively. Tables 4-5 and 4-6 contain similar information for the 100-year life cycles.

Table 4-3. South County Reuse Options Economic Comparison Summary – 30-yr Life-Cycle

	Option (M = millions)[a]		
	Option 1 (NPR+ from SBWR)	Option 2 (GWR)	Option 3 (SWA)
Estimated capital[b,c]	$70M	$75M	$95M
Estimated O&M[b,c]	$80M	$205M	$220M
Estimated R&R[b,c]	$5M	$35M	$40M
Total cost	$150M	$315M	$355M
Total cost, present value	$110M	$200M	$230M
Total yield (TAF)	87	57	57
Present value yield (TAF)	51	33	33
Life-cycle unit cost ($/AF)	$2,200/AF	$6,100/AF	$6,000/AF
Life-cycle unit cost ($/AF), excluding R&R and ROC management	$2,200/AF	$5,600/AF	$5,300/AF
ROC management life-cycle unit cost ($/AF)[c]	- -	$200/AF	$100/AF
Life-cycle unit cost including ROC management ($/AF)	$2,200/AF	$6,300/AF	$6,100/AF

a. *Capital and O&M costs are rounded up to $5 million. Life-cycle unit costs are rounded to the nearest $100/AF.*

b. *Cost estimates are considered Class 5 by AACE International and have an accuracy of +50 percent and -30 percent.*

c. *ROC management unit costs from Basis of Cost Estimates for ROC Management Options (Valley Water, 2020b).*

Table 4-4. Portfolios Economic Comparison Summary – 30-yr Life-Cycle

	Portfolio (M = millions)[a]						
	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4
Estimated capital[b,c]	$630M	$615M	$535M	$585	$735M	$755M	$775M
Estimated O&M[b,c]	$555M	$570M	$645M	$645	$585M	$560M	$610M
Estimated R&R[b,c]	$190M	$235M	$230M	$230	$190M	$190M	$220M
Total cost	$1,370M	$1,415M	$1,405M	$1,460	$1,510M	$1,505M	$1,600M
Total cost, present value	$950M	$965M	$940M	$985	$1,060M	$1,060M	$1,120M
Total yield (TAF)	570 – 720	594 – 720	720	720	510 – 690	510 – 690	510 – 690
Present value yield (TAF)	331 –419	345 – 419	419	419	297 –401	297 – 401	297 – 401
Life-cycle unit cost ($/AF)	$2,300/AF – $2,900/AF	$2,400/AF – $2,800/AF	$2,300/AF	$2,400/AF	$2,700/AF – $3,600/AF	$2,700/AF – $3,600/AF	$2,800/AF – $3,800/AF
Life-cycle unit cost ($/AF), excluding R&R and ROC management	$2,100/AF – $2,700/AF	$2,100/AF – $2,500/AF	$2,000/AF	$2,100/AF	$2,500/AF – $3,300/AF	$2,500/AF – $3,300/AF	$2,600/AF – $3,500/AF
ROC management life-cycle unit cost ($/AF)[c]	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF	$300/AF
Life-cycle unit cost including ROC management ($/AF)	$2,500 – $3,100/AF	$2,600 – $3,000/AF	$2,500/AF	$2,600/AF	$2,900 – $3,800/AF	$2,900 – $3,800/AF	$3,100 – $4,100/AF

a. *Capital and O&M costs are rounded up to $5 million. Life-cycle unit costs are rounded to the nearest $100/AF.*

b. *Cost estimates are considered Class 5 by AACE International and have an accuracy of +50 percent and -30 percent.*

c. *ROC management unit costs from Basis of Cost Estimates for ROC Management Options (Valley Water, 2020b).*

Table 4-5. South County Reuse Options Economic Comparison Summary – 100-yr Life-Cycle

	Option (M = millions)[a]		
	Option 1	Option 2	Option 3
Estimated capital[b,c]	$70M	$75M	$95M
Estimated O&M[b,c]	$260M	$680M	$730M
Estimated R&R[b,c]	$20M	$170M	$185M
Total cost	$350M	$925M	$1,010M
Total cost, present value	$145M	$315M	$350M
Total yield (TAF)	290	190	190
Present value yield (TAF)	90	59	59
Life-cycle unit cost ($/AF)	$1,700/AF	$5,400/AF	$6,000/AF
ROC management life-cycle unit cost ($/AF)[c]	- -	$100/AF	$100/AF
Life-cycle unit cost including ROC management ($/AF)	$1,700/AF	$5,500/AF	$6,100/AF

a. *Capital and O&M costs are rounded up to $5 million. Life-cycle unit costs are rounded to the nearest $100/AF.*
b. *Cost estimates are considered Class 5 by AACE International and have an accuracy of +50 percent and -30 percent.*
c. *ROC management unit costs from Basis of Cost Estimates for ROC Management Options (Valley Water, 2020b).*

Table 4-6. Portfolios Economic Comparison Summary – 100-yr Life-Cycle

	Portfolio (M = millions)[a]						
	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4
Estimated capital[b,c]	$630M	$615M	$535M	$585	$735M	$755M	$775M
Estimated O&M[b,c]	$1,840M	$1,890M	$2,140M	$2,150	$1,940M	$1,860M	$2,020M
Estimated R&R[b,c]	$1,045M	$1,185M	$1,165M	$1,190	$1,105M	$1,085M	$1,200M
Total cost	$3,515M	$3,690M	$3,840M	$3,925	$3,780M	$3,700M	$3,995M
Total cost, present value	$1,320M	$1,360M	$1,365M	$1,415	$1,450M	$1,440M	$1,535M
Total yield (TAF)	1,900 - 2,400	1,900 – 2,400	2,400	2,400	1,700 – 2,300	1,700 – 2,300	1,700 – 2,300
Present value yield (TAF)	587 – 742	594 – 742	742	742	526 – 711	526 – 711	526 – 711
Life-cycle unit cost ($/AF)[c]	$1,800/AF – $2,300/AF	$1,900/AF – $2,300/AF	$1,900/AF	$2,000/AF	$2,100/AF – $2,800/AF	$2,100/AF – $2,800/AF	$2,200/AF – $3,000/AF
ROC management life-cycle unit cost ($/AF)	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF
Life-cycle unit cost including ROC management ($/AF)[c]	$2,000 – $2,500/AF	$2,100 – $2,500/AF	$2,100/AF	$2,200/AF	$2,300 – $3,000/AF	$2,300 – $3,000/AF	$2,400 – $3,200/AF

a. *Capital and O&M costs are rounded up to $5 million. Life-cycle unit costs are rounded to the nearest $100/AF.*
b. *Cost estimates are considered Class 5 by AACE International and have an accuracy of +50 percent and -30 percent.*
c. *ROC management unit costs from Basis of Cost Estimates for ROC Management Options (Valley Water, 2020b)*

Of the South County options, only Option 1 is cost-competitive with typical water supply costs. Of the North County portfolios, Portfolio 1a has the lowest life-cycle unit cost assuming no groundwater capacity limitations. Portfolio 1c has the next lowest life-cycle unit cost and does not rely on groundwater capacity.

Section 5: Portfolio Evaluation and Risk Assessment Tool

Because this TM is not intended to result in selection of a single recommended project, the Project Team has evaluated the portfolios and performed a relative comparison based on program goals, prioritization criteria, and risk management. The evaluation focuses on comparing features and attributes of the various portfolios and options that are key differentiators. Elements that apply across all alternatives—such as NPR/NPR+ distribution system expansions—affect each portfolio/option the same and thus are not considered in this comparison.

5.1 Evaluation Criteria and Assessment Methodology

For this evaluation, prioritization criteria are consistent with those vetted and confirmed in Fall 2018 based on input from Partner Agencies and Valley Water staff, as presented in Appendix F: Conceptual Alternatives TM and used to evaluate conceptual project portfolios, with some additional detail to further define sub-criteria. Evaluation criteria and initial weighting factors are summarized in Table 5-1.

Table 5-1. Evaluation Criteria and Weighting Factors

Criteria	Sub-criteria used to score criteria	Weighting Factor[a]
Economics	Unit cost of annual yield of PR supply, estimated life-cycle costs, funding capability, and grant funding eligibility	25%
Groundwater management and Countywide (regional) supply reliability	Projected PR supply, number of PR delivery points, seasonality, dry year drought reliability, and groundwater basin quality protection	25%
Environmental impacts/benefits and sustainability	Minimizing carbon footprint (evaluated using energy use as a surrogate for carbon emissions), environmental protection with respect to ROCM, and environmental protection with respect to CEQA/NEPA impacts	20%
Ease of implementation and permitting/ regulatory considerations	Partnerships/collaboration, local ownership of reuse supply, operational simplicity, permitting/compliance (PR permits), permitting/compliance (CEQA/NEPA), readiness to proceed, public acceptance/support, and environmental and social justice	15%
Engineering feasibility	Tested and proven treatment technology, other water quality requirements	15%

a. *Initial criteria weighting from October 2018 Project Partner Group (PPG) meeting.*

Prioritization criteria provide a framework for numerical evaluation, giving way to scores that provide a basis for preliminary ranking. The preliminary scoring presented in Appendix A-7 and shown graphically in this draft is for the purpose of discussion with Valley Water, Partner Agencies, and other stakeholders. The Project Team anticipates that these values will continue to be revised and refined with input from such discussions and new information, as it becomes available.

When considering the five primary criteria alone, the portfolios receive similar scores. The additional sub-criteria help to further illuminate relative strengths and weaknesses of each portfolio. Appendix A-7 defines sub-criteria and score ranges and explains how scores were normalized to compare portfolios.

As part of the analysis, the Project Team tested different ways of weighting the prioritization criteria and sub-criteria to illustrate the sensitivity of preliminary scoring to different criteria weightings. Changing weights of criteria altered portfolio scores in distinct ways, although the overall rankings did not change significantly. Figure 5-1 presents graphs illustrating scoring sensitivity to different criteria weightings:

- Initial criteria weighting from October 2018 PPG meeting (as presented in Table 5-1)
- Equal weighting of each criteria (i.e., each criterion weighted 20%)
- Equal weighting of each sub-criteria (i.e., each sub-criterion weighted 5.2%)
- Heavily weighted toward economics (substantially lopsided weighting for demonstration purposes only)

Finalized weightings will be decided with input from Valley Water executives and project partners.

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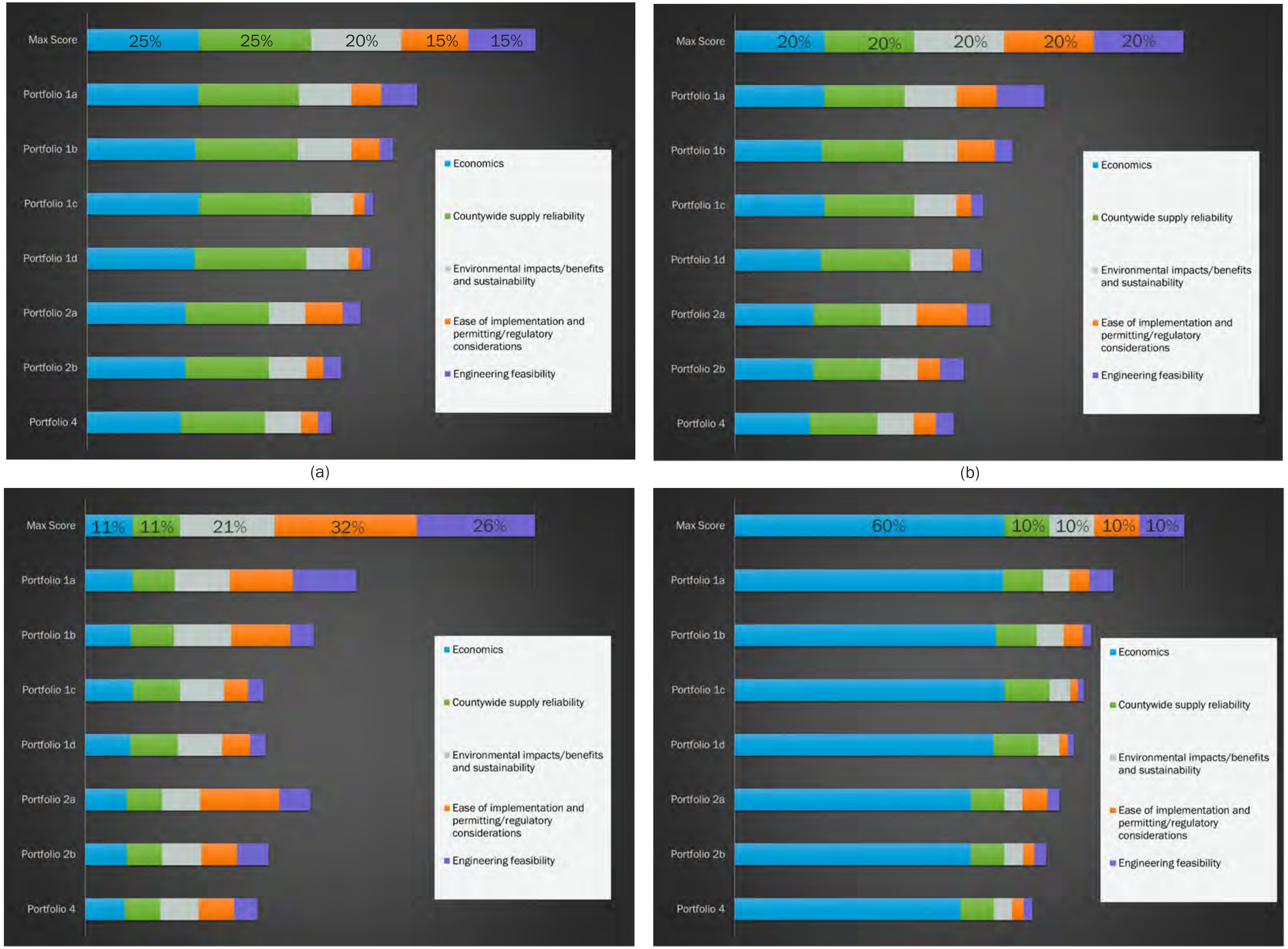

(a) (b)

(c) (d)

Figure 5-1. Evaluation results using: (a) criteria weights from October 2018 PPG meeting, (b) equal criteria weights, (c) equal sub-criteria weights, and (d) heavily weighted toward engineering feasibility

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Portfolio 1a receives the highest scores in all weighting scenarios, indicating how stable and well-balanced this portfolio is. Appendix A-7 includes more detailed discussion of weighting and sensitivity.

5.2 Risk Assessment Summary

Each portfolio carries associated potential risks: negative events or circumstances that could compromise the implementation or success of the Countywide reuse program and, thus, the ability to meet Valley Water's PR goals. The risk matrix (presented in Appendix A-7) supplements the scoring and evaluation process and presents relative risks of North County portfolios and South County options in one place. Example results from the risk assessment tool are presented in Figure 5.2.

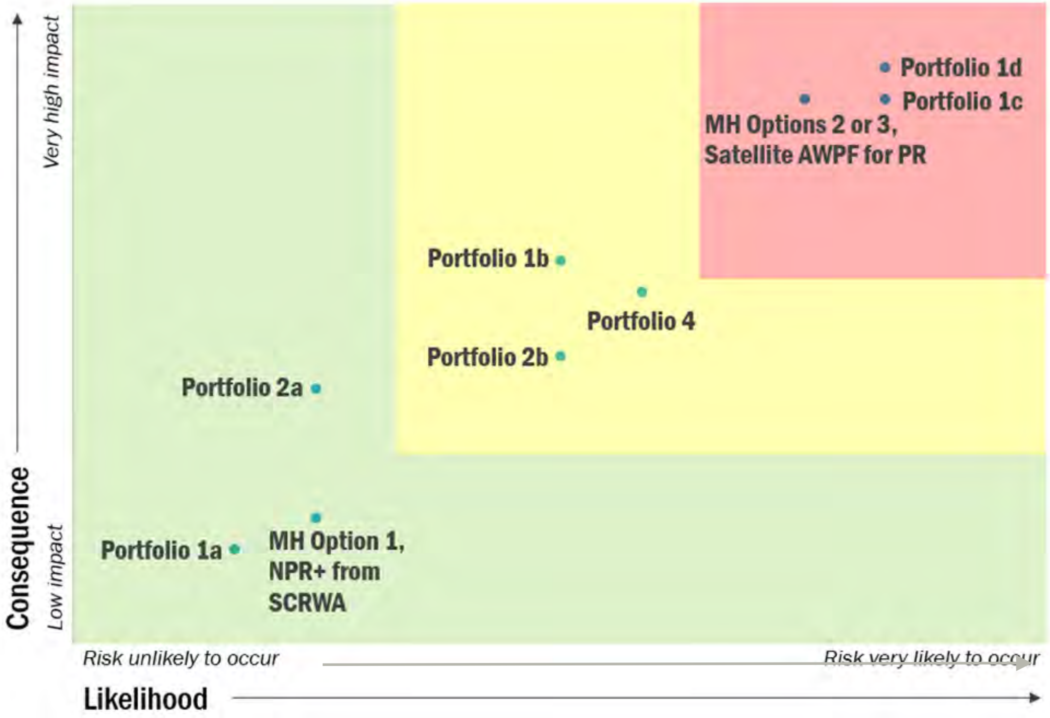

Figure 5.2 Example Risk Matrix comparison of portfolios and options with likelihood of risk occurring on the x-axis and consequence of risk occurring on the y-axis

5.3 South County Elements Evaluation

South County elements include NPR from SCRWA, NPR+ via SBWR, and the Morgan Hill satellite WWTP and AWPF, which could be used for GWR at existing percolation ponds or SWA at Anderson Reservoir. These South County elements can be included in combination with any portfolio and, therefore, are evaluated separately. A numerical evaluation comparing the four South County alternatives was ruled out because NPR and PR options are not mutually exclusive, and each serves a separate purpose. Instead, a qualitative discussion of how South County elements perform with respect to the five criteria is presented in Attachment E and summarized in Tables 5-2 and 5-3. The tables compare the two NPR options separately from the two PR options; the more beneficial option for each criterion receives a 1 and the less beneficial option receives a 0.

Table 5-2. South County NPR Options Qualitative Comparison

Criteria	Reference Point: Morgan Hill NPR from SCRWA	Option 1: Morgan Hill NPR+ from SBWR
Economics	0	1
Groundwater management and Countywide (regional) supply reliability	0	1
Environmental impacts/benefits and sustainability	0	1
Ease of implementation and permitting/ regulatory considerations	1	0
Engineering feasibility	0	1

Table 5-3. South County PR Options Qualitative Comparison

Criteria	Option 2: Morgan Hill GWR	Option 3: Morgan Hill SWA
Economics	1	0
Groundwater management and Countywide (regional) supply reliability	0	1
Environmental impacts/benefits and sustainability	0	1
Ease of implementation and permitting/ regulatory considerations	1	0
Engineering feasibility	1	0

5.4 Evaluation Sensitivity Analysis and Summary

Of the five portfolios focused on North County PR, Portfolio 1a received the highest scores for the criteria and sub-criteria and was the most “balanced” portfolio. It received some points for all criteria and most sub-criteria. Portfolios 1b, 1c, 1d, and 2a also performed well and, depending on criteria weighting, could be shown as the second, third, fourth, or fifth most favorable portfolio: scores were not as well balanced (scoring high for some criteria and not others) as for Portfolio 1a. The sensitivity analysis presented in Appendix A-7 shows that varying criteria weights does not significantly impact the order of Portfolio 1a, but it can impact other portfolios.

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Appendix A-2: Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield

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Technical Memorandum

Prepared for:	Santa Clara Valley Water District (Valley Water)
Project title:	Countywide Water Reuse Master Plan
Project no.:	4821 (Valley Water); 151772 (BC Internal)
Contract no.:	A4120A

Appendix A-2

Subject:	Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield
Date:	June 30, 2020
To:	Miguel Silva, Valley Water Project Manager
From:	Jenny Gain, P.E., Brown and Caldwell Team Project Manager
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This document presents a compilation of data and assumptions that informed the flow analysis and advanced water purification facility (AWPF) sizing as part of Valley Water's Countywide Water Reuse Master Plan (Master Plan). Information is organized in two main sections.

- **Section 1: Flow Analysis.** Summarizes the approach for evaluating various flow streams at the four wastewater treatment plants (WWTP) and estimated amount of remaining effluent potentially available for potable reuse (PR).
- **Section 2: AWPF Design Considerations.** Summarizes AWPF design capacity, efficiency, and anticipated yield of purified water for PR, based on estimated source water available.

Section 1: Flow Analysis

Selection and design of AWPF project elements was informed by estimates of remaining effluent available from each of the four WWTPs in the county, after subtracting out other uses (e.g., non-potable reuse [NPR], environmental flows, and losses). The following section describes the general methodology for evaluating flows, followed by results by Partner Agency to demonstrate how the analysis played out for each WWTP.

1.1 Methodology

Using historical data and future flow projections, a flow balance was performed to estimate the remaining effluent available for discharge, blending, or additional reuse from each of the four WWTPs in Santa Clara County in 2035. As demonstrated in Figure 1 and further described below, the flow streams considered in the analysis included WWTP influent, NPR, environmental flows, and losses (e.g., evaporation). Because NPR expansion projects are already planned by each Partner Agency, the Master Plan assumes projected NPR demands will remain intact, and PR projects will be sourced by remaining effluent (minus any effluent reserved for discharge, blending, or other requirements).

Definition:
remaining effluent

Remaining effluent refers to the amount of secondary- or tertiary-treated wastewater available for potable reuse (or other uses such as discharge or blending) after non-potable reuse (NPR) demands, losses, and environmental flows are met. For planning purposes, the Master Plan assumes all remaining effluent would be available for potable reuse.

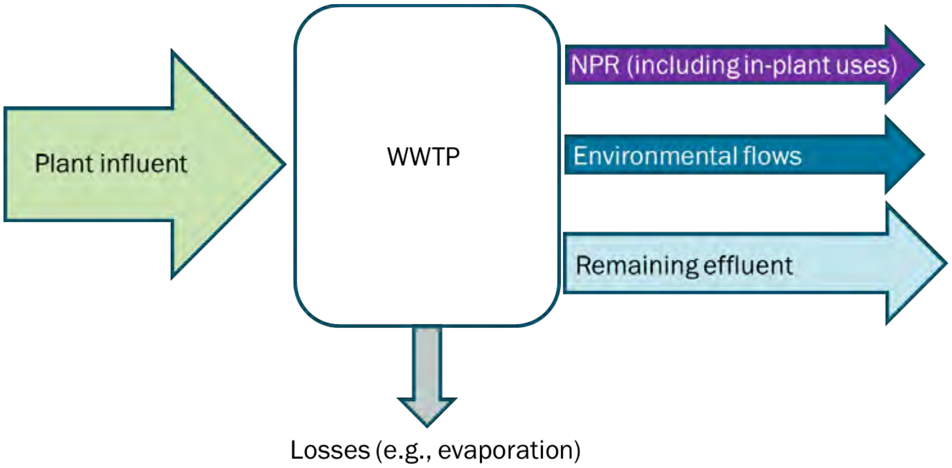

Figure 1. WWTP inflow and outflow streams considered in the flow analysis

1.1.1 WWTP Influent

Baseline conditions. Daily influent flows at each of the four WWTPs were downloaded from the California Integrated Water Quality System (CIWQS) database.[1] Average monthly median flows from 2014-2018 were used to establish baseline conditions.

Future projections of average dry weather flow. Partner Agencies' wastewater and recycled water master plans present future influent projections as average dry weather flow (ADWF), or the lowest consecutive three-month average. These plans were used as the starting point for estimating future influent projections in the Master Plan; however, the latest available planning documents were prepared prior to the recent extreme drought, and thus overestimated influent flows for 2015 onward. Recent trends suggest influent flows may not increase at rates previously projected, due to conservation and long-term water use efficiency.

Definition: average dry weather flow

Average dry weather flow (ADWF) is the average daily WWTP influent during the three lowest consecutive flow months of the year (e.g., June through August or July through September), typically presented in million gallons per day (mgd).

To account for the uncertainty in future influent projections (due to changes in water use/land use and population growth/density), the Master Plan considers a range of future flow conditions by starting with influent projections through 2035[2] from Partner Agencies' planning documents, adjusting downward to match the 2014-2018 baseline and considering a range of flows:

- **Lower bound** – assumes no increase from baseline (flatlined projection).
- **Upper bound** – assumes same slope (i.e., rate of increase) from Partner Agencies' planning documents. (If the planning document included multiple projection curves, the flattest slope was applied).

The resulting ADWF projections used in the Master Plan are summarized in Table 1.

---

[1] https://ciwqs.waterboards.ca.gov/ciwqs/readOnly/CiwqsReportServlet?inCommand=reset&reportName=esmrAnalytical#

[2] Although 2040 is the planning horizon for the Master Plan, 2035 was used for the flow analysis based on projections available in Partner Agencies' planning documents. Using 2035 also provides a more conservative estimate of available flow, since influent will likely remain constant or increase between 2035 and 2040 (according to current projections).

Table 1. Range of Projected 2035 WWTP Influent Flows

WWTP	Projected ADWF (mgd), using 2014-2018 baseline [a] Lower Bound: Flatlined Projection	Upper Bound: Increasing ADWF [b]
San José/Santa Clara Regional Wastewater Facility (RWF)	98.4	106
Palo Alto Regional Water Quality Control Plant (RWQCP)	17.7	19.6
Sunnyvale Water Pollution Control Plant (WPCP)	11.2 [c]	15.9
South County Regional Wastewater Authority (SCRWA)	6.0 [d]	6.0 [d]

a. *ADWF was calculated using average of monthly median flows from 2014-2018. Influent flow data was downloaded from the CIWQS database.*
b. *Rate of increase based on slopes from individual agencies' influent projection curves (in past wastewater or recycled water plans)*
c. *Actual Sunnyvale WPCP influent is approximately 0.5 mgd lower than the values reported in CIWQS, due to a difference in metering location.*
d. *SCRWA WWTP influent was already projected to remain constant over time (at approximately 6 mgd), so the lower and upper bound projections are the same.*

Converting ADWF to Monthly Flow Projections. By definition, ADWF values do not reflect the higher flows of winter months. To account for seasonal variation in flow, future ADWF was converted to monthly flows, using monthly distribution factors based on historical flow data. (Note: this conversion was only necessary for the upper bound of future influent projections, since the lower bound is already reflective of historical conditions).

Monthly distribution factors were calculated for each WWTP by dividing historical (baseline) monthly flows by the lowest consecutive three-month average. These factors were then multiplied by future projected ADWF to estimate future monthly influent.

Historical (baseline) monthly influent and the resulting distribution factors (monthly flow divided by ADWF) are summarized in Table 2.

Table 2. Current Flows: Baseline WWTP Influent and Monthly Distribution Factors

	SJ/SC RWF		Palo Alto RWQCP		Sunnyvale WPCP[a]		SCRWA WWTP	
Month	Baseline Influent (mgd)[b]	Monthly Distribution Factor	Baseline Influent (mgd)[b]	Monthly Distribution Factor	Baseline Influent (mgd)[b]	Monthly Distribution Factor	Baseline Influent (mgd)[b]	Monthly Distribution Factor
Jan.	103.7	1.1	21.0	1.2	12.8	1.1	6.7	1.1
Feb.	104.1	1.1	21.9	1.2	12.9	1.2	7.2	1.2
March	104.5	1.1	21.6	1.2	13.0	1.2	7.0	1.2
April	101.7	1.0	20.4	1.2	12.3	1.1	6.6	1.1
May	98.8	1.0	19.7	1.1	11.9	1.1	6.3	1.1
June	99.7	1.0	19.0	1.1	11.7	1.0	6.1	1.0
July	98.3	1.0	17.9	1.0	11.3	1.0	6.0	1.0
Aug.	100.2	1.0	17.8	1.0	11.3	1.0	6.0	1.0
Sep.	99.0	1.0	17.5	1.0	11.1	1.0	5.9	1.0
Oct.	99.1	1.0	17.8	1.0	11.1	1.0	5.9	1.0
Nov.	97.3	1.0	17.9	1.0	11.3	1.0	6.0	1.0
Dec.	99.3	1.0	19.0	1.1	12.0	1.1	6.1	1.0
ADWF	98.4		17.7		11.2		6.0	

a. *The Sunnyvale WPCP influent that is reported to CIWQS includes, on average, 0.5 mgd of internal plant recycle (as clarified by Sunnyvale staff) and does not reflect actual flow coming into the plant. Thus, the Sunnyvale influent numbers, as reported to CIWQS, were reduced by 0.5 mgd to more accurately report the flow entering the plant.*
b. *Baseline influent = average of monthly median flows, 2014-2018.*

1.1.2 NPR Demands, Environmental Flows, and Losses

The following outflow streams were considered for each WWTP, based on current and projected future uses.

Non-potable reuse. 2015 Urban Water Management Plans (UWMP), developed by water suppliers in coordination with recycled water producers, generally contain the most recent NPR demand projections and were, therefore, used as the basis for future NPR, with a few exceptions:

- South Bay Water Recycling (SBWR) provided updated NPR projections in January 2019, representing increased recycled water demand across the service area.
- Morgan Hill's 2015 UWMP projected zero long-term NPR deliveries; however, because an NPR project in Morgan Hill may be feasible in the context of a larger, countywide plan, the Master Plan uses Morgan Hill's conceptual buildout demands from the 2015 South County Recycled Water Master Plan Update.

For more detailed information on potential future NPR projects, such as target customer areas and recommended pipeline alignments, water retailers' individual recycled water planning documents were reviewed (as referenced in Appendix A-1, Table 2-15); however, these plans generally predate the 2015 UWMPs, and the total projected NPR demands do not always align. In the case of discrepancies, NPR demand projections from 2015 UWMPs were used (unless otherwise specified).

NPR demand projections by Partner Agency are summarized in Table 3. Though typically presented as annual volumes (in acre-feet per year [AFY]) for planning purposes, Table 3 also shows demands in mgd for reference. These demands include recycled water used in and around the Palo Alto RWQCP and SCRWA WWTP. They do not necessarily reflect contractual obligations (e.g., Mountain View is entitled to up to 3 mgd from Palo Alto [an instantaneous value], though average projected NPR use is lower). Current contractual obligations are noted in Table 3 and discussed further in Section 1.2 (Other Considerations).

Table 3. Summary of Projected NPR Demands by Partner Agency

Partner Agency	Water Retailers	2040 NPR Demand [a]		Current Contractual Obligation [b]
		AFY	Mgd (annual average)	
PA/MV RWS	City of Palo Alto City of Mountain View	2,800	2.5	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	City of Sunnyvale California Water Service Company (Cal Water) (Cupertino) San Jose Water (Cupertino)	1,700	1.5	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	City of Santa Clara San José Municipal Water System (SJMWS) San Jose Water City of Milpitas	30,900 [c]	27.6 [c]	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline (through January 22, 2027, unless agreement is extended)
SCRWA	City of Gilroy City of Morgan Hill	3,700 2,900[d]	3.3 2.6[d]	N/A
County total		42,000	37.5	

a. Projected 2040 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY, unless otherwise specified.

b. Projected NPR demands do not fully capture potential allocations per contractual agreements.

c. Updated NPR demands provided by SBWR staff in January 2019.

d. Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.

PA/MV = Palo Alto/Mountain View

RWS = recycled water system

N/A = not applicable

Although future NPR projections are presented as average annual demands, NPR use varies seasonally. Therefore, similar to the process for converting future ADWF to monthly influent projections, monthly distribution factors were used to estimate future monthly NPR demand.

Average historical monthly NPR demands (based on 2015-2017 data provided by partner agencies) were divided by average annual demand to calculate a monthly factor. Historical monthly NPR demands and the resulting distribution factors are shown in Table 4. These factors were then multiplied by projected annual NPR demand to estimate future monthly NPR demand.

Table 4. Current Demands: NPR Demand and Monthly Distribution Factors for Each WWTP

Month	San José/Santa Clara RWF		Palo Alto RWQCP		Sunnyvale WPCP		SCRWA WWTP	
	NPR demand (2015-17 average, mgd)	Monthly Distribution Factor	NPR demand (2015-17 average, mgd)	Monthly Distribution Factor	NPR demand (2015-17 average, mgd)	Monthly Distribution Factor	NPR demand (2015-17 average, mgd)	Monthly Distribution Factor
Jan.	6.7	0.6	0.1	0.2	0.4	0.4	1.2	0.7
Feb.	6.5	0.5	0.2	0.3	0.4	0.5	1.0	0.5
March	7.4	0.6	0.3	0.4	0.6	0.7	1.4	0.8
April	9.6	0.8	0.5	0.9	0.9	1.0	1.7	0.9
May	13.6	1.1	0.9	1.4	1.2	1.3	2.0	1.1
June	17.9	1.5	1.0	1.7	1.5	1.7	2.6	1.4
July	19.5	1.6	1.1	1.8	1.4	1.6	2.8	1.5
Aug.	19.0	1.6	1.2	2.0	1.5	1.7	2.9	1.6
Sep.	17.2	1.4	1.0	1.6	1.4	1.5	2.2	1.2
Oct.	14.3	1.2	0.7	1.1	0.9	1.0	1.9	1.0
Nov.	7.4	0.6	0.2	0.4	0.3	0.4	1.3	0.7
Dec.	5.9	0.5	0.2	0.3	0.2	0.2	1.2	0.6
Average	12.1		0.6		0.9		1.9	

Losses associated with enhanced NPR (NPR+). To improve water quality of recycled water in terms of target levels of total dissolved solids (TDS), purified water can be blended with Title 22 recycled water, resulting in enhanced NPR or NPR+.

SBWR is currently the only Partner Agency that delivers NPR+, which meets a TDS target of less than 500 milligrams per liter (mg/L) by blending purified water from the Silicon Valley Advanced Water Purification Center (SVAWPC) with Title 22 recycled water.

Palo Alto is planning a local AWPF for NPR+. Additionally, if NPR systems in North County were connected through interties, Sunnyvale may also consider an AWPF to provide water quality consistent with SBWR and PA/MV systems. Therefore, the flow analysis for systems in

Definition:
enhanced NPR (NPR+)

Enhanced NPR, or **NPR+**, is achieved by blending Title 22 recycled water with purified water for improved water quality (e.g., TDS <500 mg/L). The lower salinity of NPR+ compared to Title 22 recycled water makes it more suitable certain non-potable uses (e.g., landscape irrigation).

North County considers not just NPR demand but the effluent required for NPR+, which accounts for the additional treatment losses (i.e., reverse osmosis concentrate [ROC]) associated with the advanced treatment process. (Note: the analysis assumes microfiltration/ultrafiltration [MF/UF] backwash returns to the front of the plant.)

The amount of purified water required for blending varies by facility, given the range in effluent TDS at each WWTP. The purified water required per unit of effluent (shown in Table 5 below) was calculated using existing water quality data and assuming a target TDS of 500 mg/L. Assuming an RO recovery rate of 85 percent, ROC is then calculated as:

$$ROC = (1 - 0.85) * \left(\frac{\text{purified water needed for blending}}{0.85}\right)$$

Table 5. NPR+ Blending Requirements

WWTP	Effluent TDS (mg/L)	Purified Water Flow per Unit Effluent Flow	Purified Water Flow Percent
PA RWQCP	847[a]	0.771	43.5%
Sunnyvale WPCP	930[b]	0.956	48.9%
SJ/SC RWF	720[c]	0.489	32.8%

a. *Average of TDS readings from 2015–17, as reported to California State Water Resources Control Board.*

b. *Average TDS from 2007–11 per City of Sunnyvale Feasibility Study for Recycled Water Expansion (FSRWE) (June 2013).*

c. *Per SBWR's 2014 SMP, Appendix 4A.*

Because South County does not have any planned NPR+, the flow analysis assumes SCRWA will continue producing the same quality recycled water for NPR.

Environmental flow requirements. Currently, Palo Alto RWQCP is the only WWTP in the county obligated to provide flow for environmental benefit under National Pollutant Discharge Elimination System (NPDES) permit requirements. Approximately 1 mgd of RWQCP effluent is provided to the Renzel Marsh project. In the future, Renzel Marsh may be expanded to receive up to 3 mgd on average. Though environmental flow requirements may vary seasonally, the flow analysis for 2035 assumes 3 mgd sent to Renzel Marsh year-round.

No environmental flow requirements were identified for the SJ/SC RWF, Sunnyvale WPCP, or SCRWA WWTP.

Other losses. While treatment losses at the WWTPs were generally assumed to be negligible, unless otherwise specified the following losses were considered at the Palo Alto RWQCP and Sunnyvale WPCP per input from their respective staff.

- **Palo Alto RWQCP – 0.3 mgd lost from recirculated flow.** The Palo Alto RWQCP recirculates some effluent for in-plant uses (e.g., wet scrubber water and filter backwash), and experiences a 20 percent loss of the recirculated flow, which equates to approximately 0.3 mgd. (Note: recycled water for in-plant uses is captured within the NPR demands).
- **Sunnyvale WPCP – 4 mgd for evaporation and capping.** The Sunnyvale WPCP experiences some evaporative losses associated with the use of ponds as part of its treatment process. Current evaporative losses are typically between 1 and 2 mgd. Future average losses at the Sunnyvale WPCP associated with its pond system are assumed to be 4 mgd, including flows for capping, evaporation, and other losses. Although these losses may vary seasonally (e.g., higher evaporation in summer), the flow analysis assumes 4 mgd year-round as a conservative estimate.

1.1.3 Remaining Effluent

Remaining effluent (i.e., WWTP influent minus losses, environmental flows, and NPR demands) may be available for discharge, blending, or additional reuse. Currently, remaining effluent in North County is discharged to the San Francisco Bay, while South County effluent is sent to percolation ponds or discharged to the Pajaro River (and eventually Monterey Bay) in rainy months.

For the purpose of this planning-level estimate, it was assumed that all remaining effluent was available for PR, and potential AWPFs were sized accordingly.

1.2 Other Considerations

Contractual obligations. As noted above, the flow analysis is based on projected water use and does not necessarily reflect current contractual arrangements. For example, Mountain View is entitled to up to 3 mgd from Palo Alto, though this is not captured in the NPR demands as projected NPR is lower. Contractual obligations are noted where applicable throughout the Master Plan and considered as part of the portfolio evaluation and risk assessment. New or revised agreements may be required for certain project elements or portfolios to proceed.

Discharge, blending, or other requirements. The flow analysis only considered current and planned uses of effluent and did not incorporate other potential future uses, such as blending for ROC management. For the initial planning-level estimate, it was assumed all remaining effluent would be available for PR. If other requirements arise, it may reduce the available effluent at certain times of the year.

Onsite reuse. The extent of future onsite (decentralized) reuse in the County may have implications for centralized reuse facilities. While onsite reuse projects can promote public awareness of water reuse and offer potential energy savings, they also reduce the amount of wastewater available for potable reuse and could lead to higher solids concentrations in sewers. Four onsite reuse projects are under development in Mountain View, with potential additional projects being explored elsewhere in the County. Future onsite reuse efforts will require coordination among multiple stakeholders, including Valley Water and the Partner Agencies, to evaluate potential impacts on the Master Plan.

1.3 Results by Partner Agency

Though the approach for evaluating available flow was similar for each Partner Agency, each WWTP has unique conditions and requirements. To confirm and refine assumptions with each Partner Agency, the Project Team summarized results from the analysis in a slidedoc format for each WWTP in North County and reviewed with Partner Agency staff. These slidedocs present flow availability under different scenarios and are included herein as Attachment A.

For South County, the potable reuse options evaluated in the Master Plan include satellite treatment in Morgan Hill, rather than sourcing a new AWPF with effluent from SCRWA WWTP. Therefore, the flow analysis considered wastewater available in Morgan Hill rather than performing a flow balance at SCRWA WWTP.

1.4 Monthly Flow Summaries

Projected monthly flow streams at each WWTP are summarized in Attachment B, including estimated effluent available for reuse and the resulting purified water yield (based on selected AWPF capacity, as discussed in Section 2).

Section 2: AWPF Design Considerations

The flow analysis informed potential AWPF design capacities and anticipated yield of purified water for PR, as described below.

2.1 AWPF Sizing Methodology

Potential AWPFs were sized to maximize production of purified water for PR (up to Valley Water's 24,000 AFY goal) while maintaining a reasonable **efficiency**. Attachment C includes summary tables that show anticipated yield and AWPF efficiency at various production capacities. These tables informed the selected design capacity for each potential AWPF.

Because the SJ/SC RWF has sufficient effluent available to produce 24,000 AFY for PR, the potential new AWPF in San José was sized at 24 mgd production capacity (assuming a 90 percent online factor). In other words, although the plant would have capacity to produce 24 mgd (equivalent to nearly 27,000 AFY if operating 365 days/year), the design assumes the AWPF will be online 90 percent of the time and produce an annual volume of 24,000 AF.

In Palo Alto and Sunnyvale, there likely will not be enough effluent available to produce 24,000 AFY of purified water; therefore, for portfolios with a potential new AWPF in Palo Alto and/or Sunnyvale, AWPFs were sized considering **incremental efficiency** (i.e., the additional purified water produced relative to the increase in design capacity, or "bang for the buck"). Beyond a certain design capacity, there are diminishing returns—that is, adding more capacity yields relatively little additional purified water and may not be worth the additional cost.

For example, the proposed 14-mgd AWPF in Palo Alto is expected to yield approximately 13,200 AFY of purified water (84 percent efficiency). If solely aiming to maximize purified water production, the AWPF could be sized at 16 mgd (estimated yield = 13,600 AFY at 76 percent efficiency). However, the additional 2 mgd capacity only yields an additional 400 AFY in purified water (<20% incremental efficiency).

Definition: efficiency

Efficiency of an AWPF, also called "AWPF utilization", is calculated as purified water produced divided by the facility's design capacity. Efficiency takes into account the AWPF's **online factor** (i.e., percent of time equipment is online vs. offline for regular maintenance) as well as source water availability.

Incremental efficiency refers to the additional purified water that would be produced relative to an increase in design capacity (e.g., if increasing the capacity of an AWPF by 2 mgd would produce an additional 1 mgd of purified water on average, the incremental efficiency would be 50%).

Because there are multiple months throughout the year during which the AWPF would be operating below capacity (i.e., AWPF efficiency is limited by source flow), it was assumed that offline activities (e.g., clean-in-place, maintenance) would occur during those times, as long as the AWPF efficiency is less than the assumed online factor of 90 percent.

For preliminary designs, the "upper bound" of influent (and resulting effluent available) was used for AWPF sizing. Under "lower bound" conditions, the AWPFs in Palo Alto and Sunnyvale would be downsized to maintain a reasonable efficiency. Given uncertainty in future flow availability, the intent is for AWPFs to be constructed modularly to allow for incremental expansion if and when more flow becomes available.

2.2 Anticipated Annual Yield

Anticipated purified water yields (based on source water availability and selected AWPF capacity) are shown in Table 6 for each potential AWPF. More detailed results of the AWPF sizing calculation, including selected capacity, efficiency, and anticipated yield are included in Attachment C. These results demonstrate how each portfolio would contribute to Valley Water's goal of 24,000 AFY of purified water for PR.

The values presented in Table 6 are based on source water availability and assume no limitations at the delivery point. However, during wet years, purified water yield may be limited by groundwater levels and the availability of other water supplies. Valley Water's Water Evaluation and Planning (WEAP) model indicates average capacity of the groundwater basin (over a range of hydrologic years) will limit long-term average yield to 18,500 AFY for portfolios involving groundwater recharge.[3]

Definition: Yield

Yield, often presented as an annual volume, is the amount of purified water produced for PR. Yield is generally lower than the maximum production (design) capacity due to source water availability, maintenance, and other factors that affect AWPF efficiency.

Table 6. Annual Yield for PR

Facility	Anticipated Yield (AFY)
Portfolio 1 - San José AWPF	24,000
Portfolio 2 - Combined Regional AWPF (in Palo Alto or Sunnyvale)	17,300 – 23,000
Portfolio 4 - Separate Palo Alto AWPF	11,700 – 13,200
Portfolio 4 - Separate Sunnyvale AWPF	5,500 – 9,800
Morgan Hill Satellite AWPF	1,900

Annual yields are estimated for planning purposes and cannot be guaranteed; however, some portfolios are more sensitive to changes in future flow conditions than others, as captured in Appendix A-7: Evaluation and Risk Assessment Tool. Based on projected flow conditions, Portfolio 1 (AWPF in San José) is the only option likely to meet the 24,000 AFY goal. Though Portfolios 2 and 4, which rely on flow from Palo Alto and Sunnyvale, have limited effluent availability and may not produce 24,000 AFY, they would still contribute to the Master Plan's overall objective of improving water supply reliability through water reuse for Santa Clara County.

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[3] Valley Water, 2018. *Expedited Purified Water Program Plan Final Report.*

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Attachment A: Flow Analysis Summaries by Partner Agency (North County)

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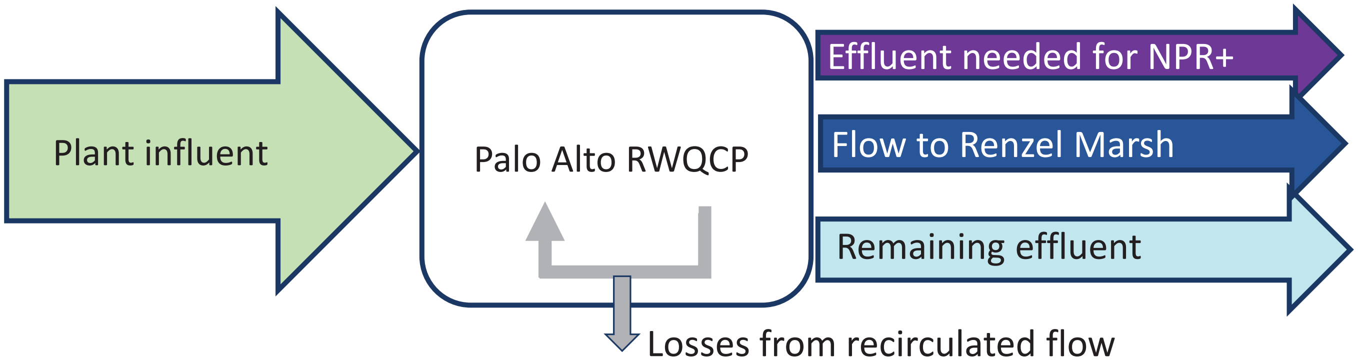
Palo Alto RWQCP

Historical and Projected Future Flow Conditions

May 5, 2020

Flow Analysis Methodology

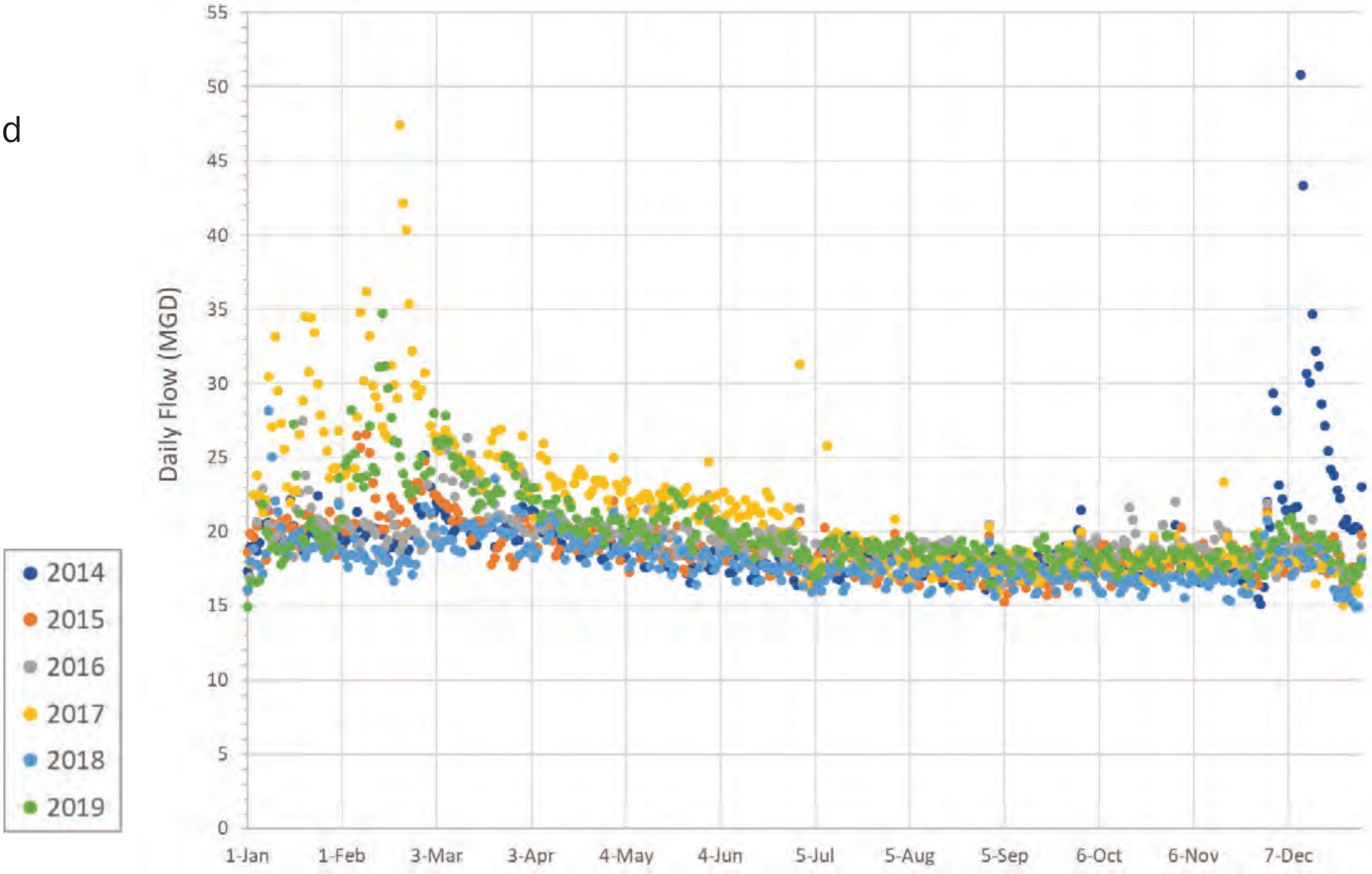
- Uses future influent, NPR demand projections, Renzel Marsh flows, and losses to estimate remaining effluent available.
- Considers a range of future influent flows, using 2014-2018 influent data (downloaded from CIWQS*) to determine baseline conditions.
    - ➢Conservative estimate (lower bound) assumes no increase in influent



*eSMR Analytical Report:
http://ciwqs.waterboards.ca.gov/ciwqs/readOnly/CiwqsReportServlet?inCommand=reset&reportName=esmrAnalytical

Palo Alto RWQCP Influent
Average Daily Flows, 2014 through 2019

- Range: 15 to 51 mgd
- 99% of daily flows exceeded 16 mgd

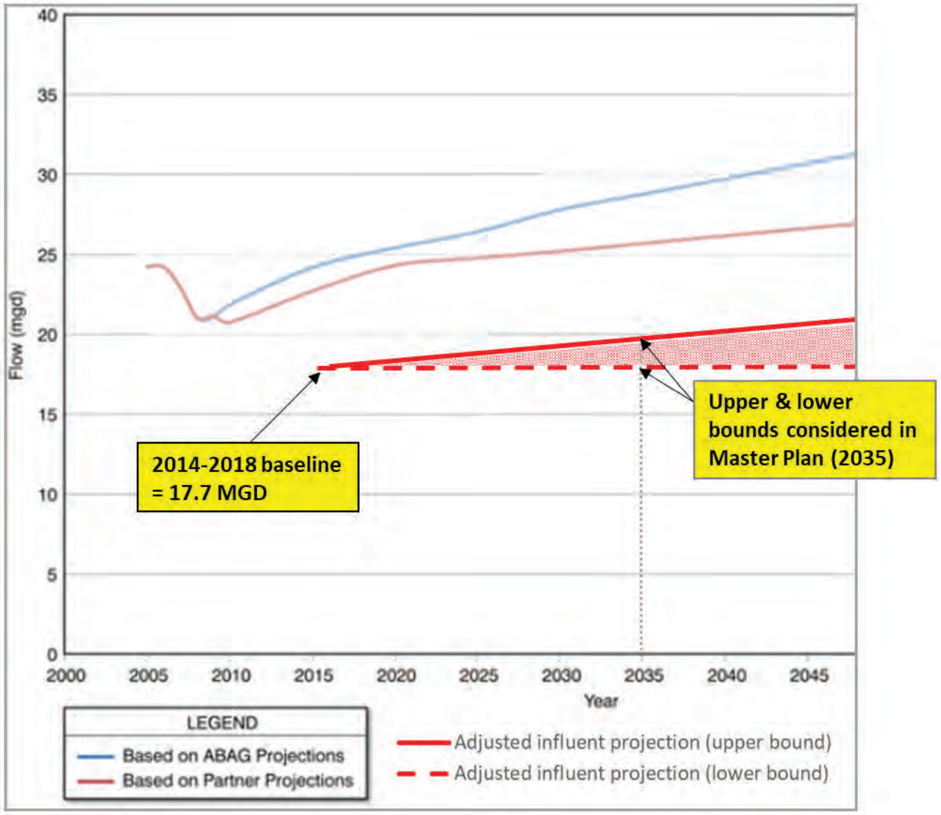


Palo Alto RWQCP Influent
Future ADWF Projections – based on Palo Alto Long Range Facilities Plan

1) Started with Palo Alto Long Range Facilities Plan
2) Adjusted downward to reflect lower flow conditions, based on 2014-2018 actuals and assuming same rate of increase (solid red line)
3) Estimated lower bound assuming no flow increase (dashed red line)

ADWF = average dry weather flow (lowest consecutive 3-month average)

Figure 3.4 Existing and Projected Average Dry Weather Flow into RWQCP

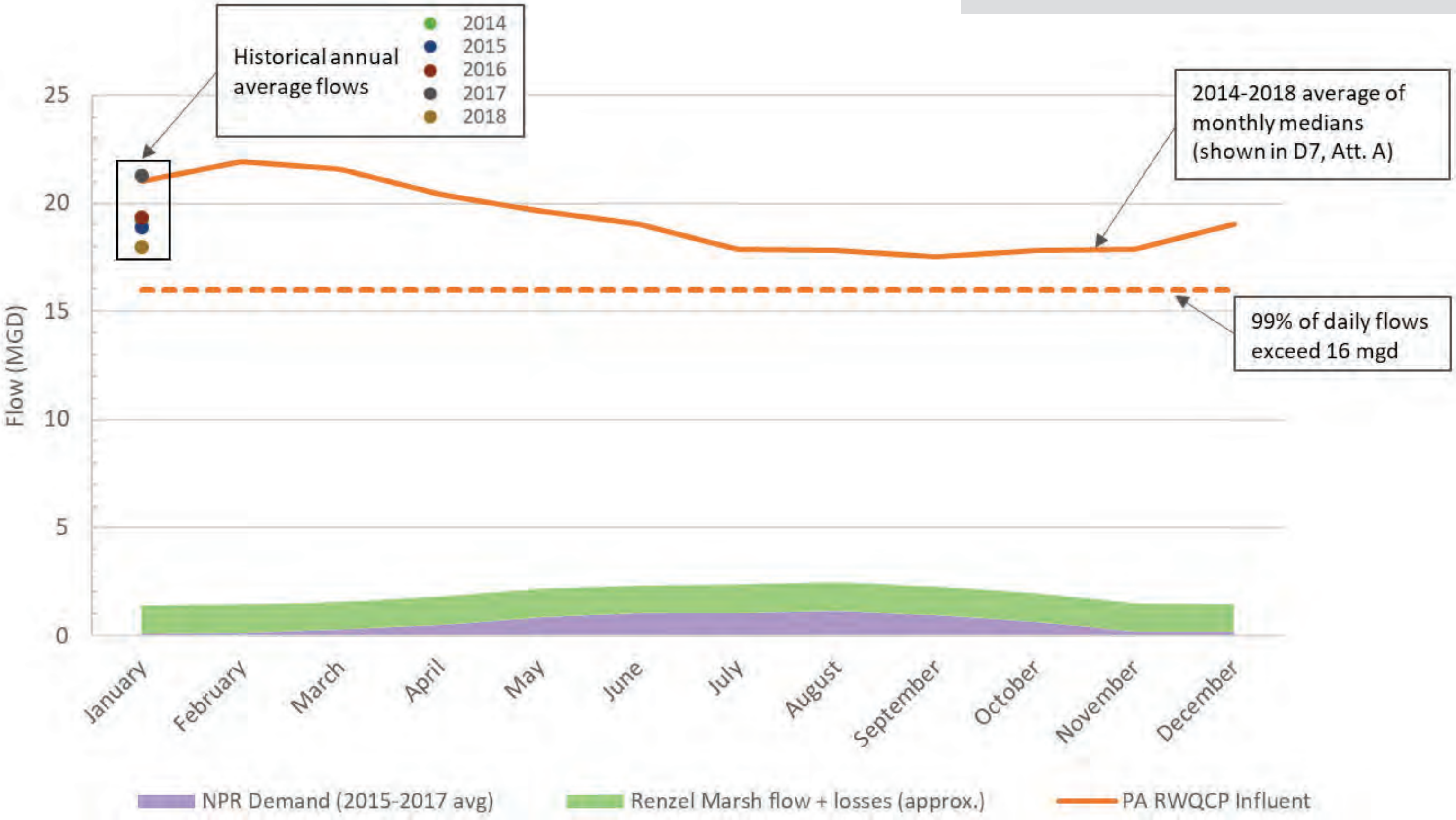


2014-2018 baseline = 17.7 MGD

Upper & lower bounds considered in Master Plan (2035)

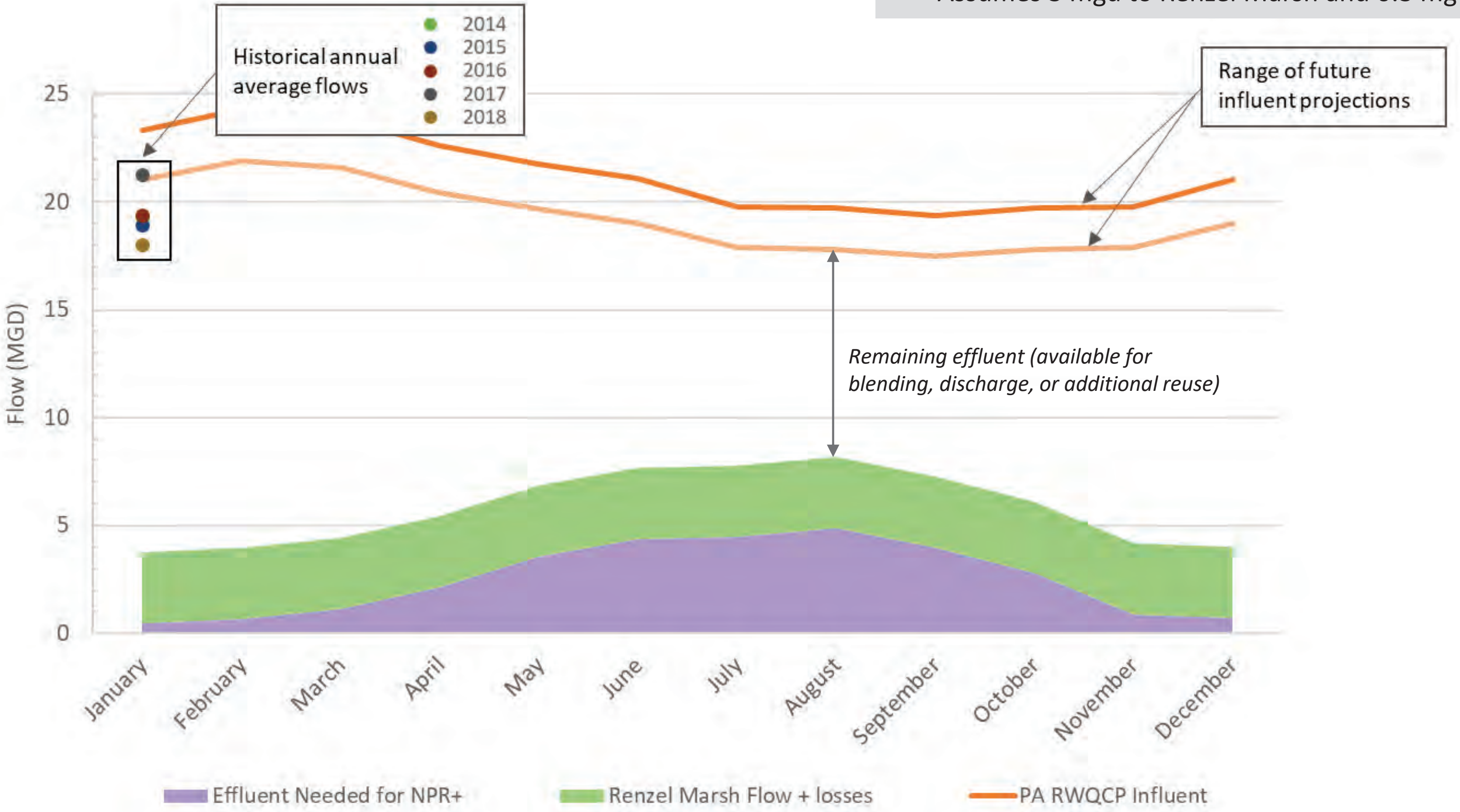
Palo Alto RWQCP Flows – Existing Conditions

- Based on actual influent flow data from CIWQS (2014-2018) and NPR production data provided by Palo Alto staff (2015-2017).
- Assumes 1 mgd to Renzel Marsh and 0.3 mgd lost from recirculated flow



Palo Alto RWQCP Flows – Future Conditions (2035 Projections)

- Lower bound of future influent assumes flows remain the same as current conditions; upper bound assumes flows increase at rate projected in Palo Alto Long-Range Facilities Plan
- NPR projections from Palo Alto's 2015 UWMP; includes additional flow required for NPR+
- Assumes 3 mgd to Renzel Marsh and 0.3 mgd losses



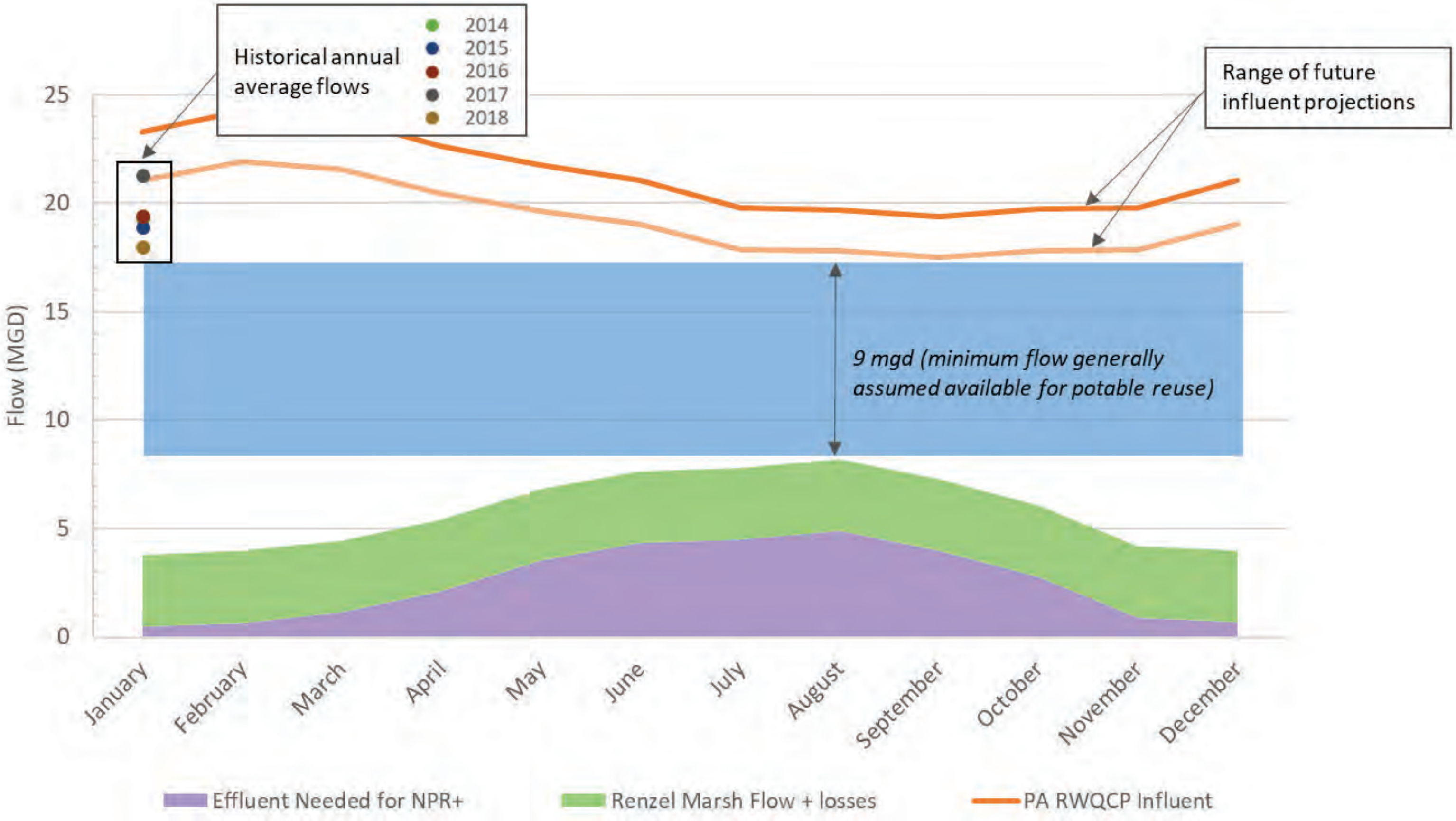
Historical annual average flows

Range of future influent projections

Remaining effluent (available for blending, discharge, or additional reuse)

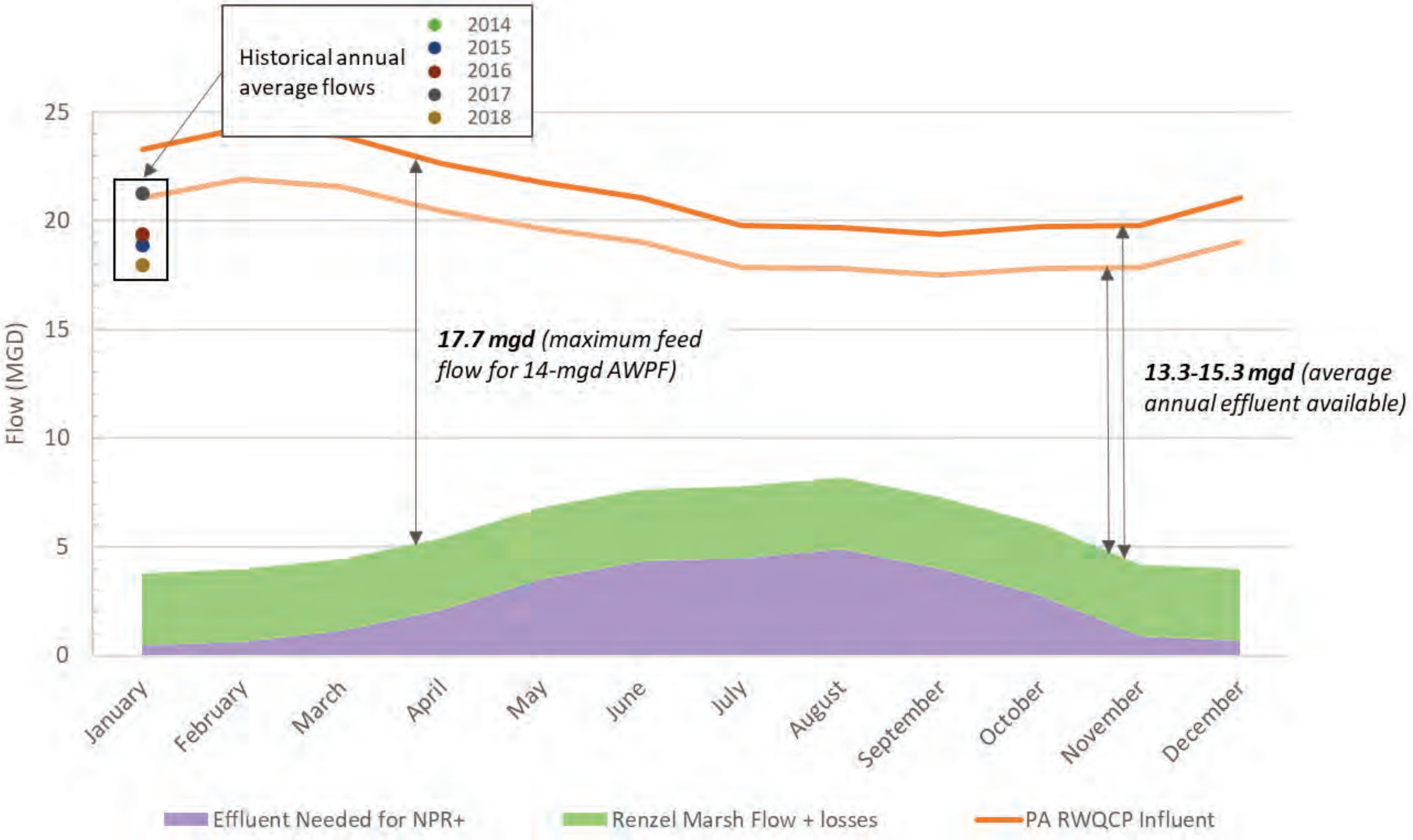
Palo Alto RWQCP Flows – Future Conditions (2035 Projections)

2035 projections show at least 9 mgd of effluent will on average be available year-round, with more flow available in the winter months.



Palo Alto RWQCP Flows – Future Conditions (2035 Projections)

- Average effluent assumed available for reuse is 13.3-15.3 mgd
- The maximum source flow for a 14-mgd AWPF is 17.7 mgd (typically only available Jan-March)



Conclusions

- 9 mgd of effluent is generally available year-round (>99% of days), with larger flows available in winter months (20 mgd on average).
- Average available effluent ranges from 13.3 mgd (low estimate) to 15.3 mgd (high estimate) annually.
- The potential 14-mgd AWPF was sized to capture higher winter flows (maximum feed flow = 17.7 mgd), noting the facility will not operate at full capacity year-round.
    - ➢Under "upper bound" conditions, expected 84% efficiency.
    - ➢Under "lower bound" conditions, AWPF would be downsized to 12 mgd to maintain 84% efficiency.
- Instantaneous peaks & dips would be managed through equalization.

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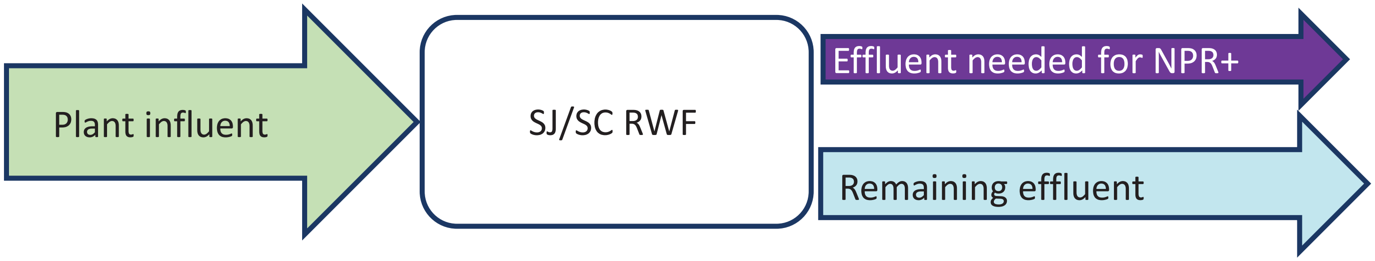
San José/Santa Clara RWF

Historical and Projected Future Flow Conditions

April 22, 2020

Part 1 – Influent Analysis

- Uses future influent and NPR demand projections to estimate remaining effluent available.
- Considers a range of future influent flows, using 2014-2018 influent data (downloaded from CIWQS*) to determine baseline conditions.
  - ➢Conservative estimate (lower bound) assumes no increase in influent


Plant influent

SJ/SC RWF

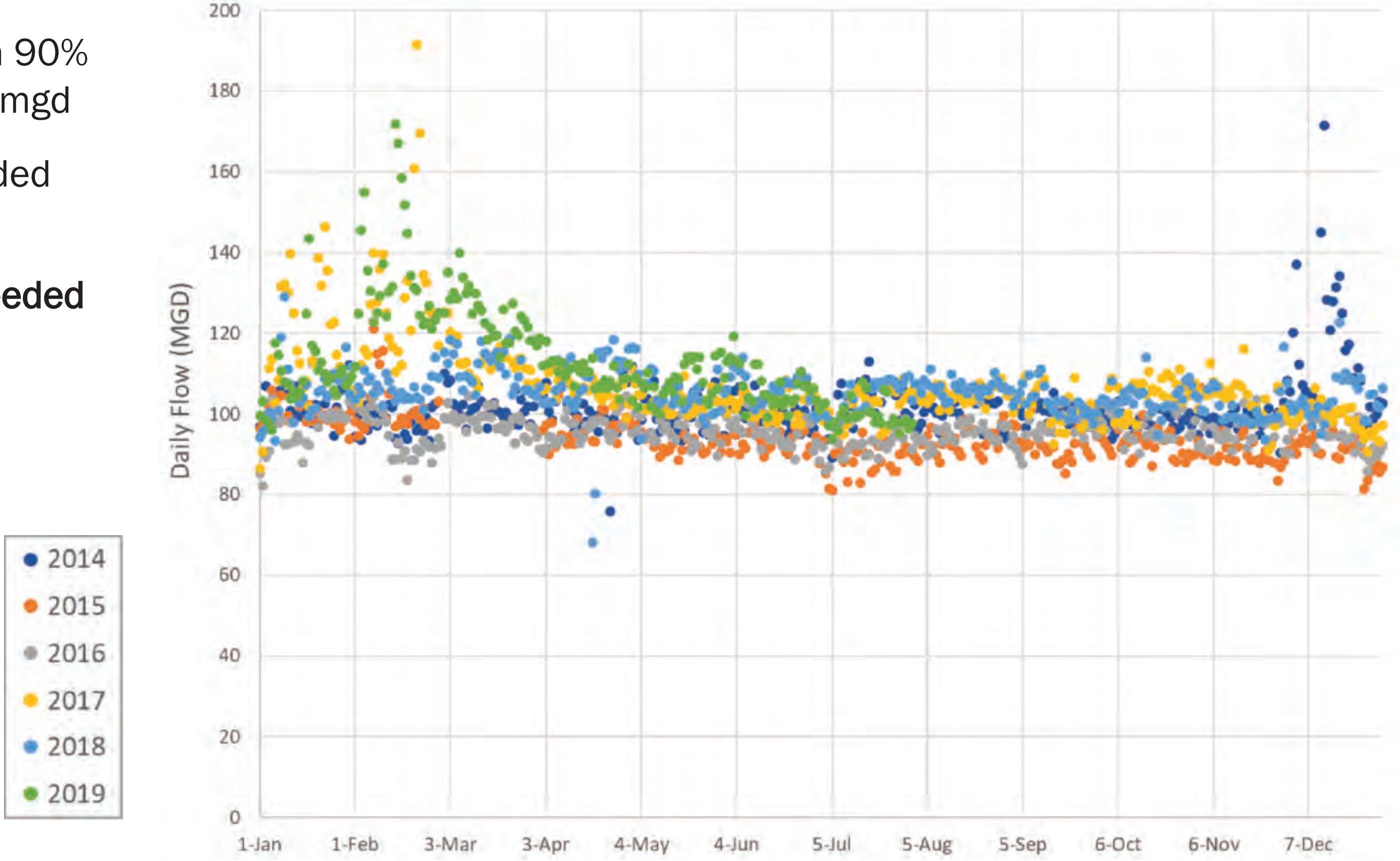
Effluent needed for NPR+

Remaining effluent

*eSMR Analytical Report:
http://ciwqs.waterboards.ca.gov/ciwqs/readOnly/CiwqsReportServlet?inCommand=reset&reportName=esmrAnalytical

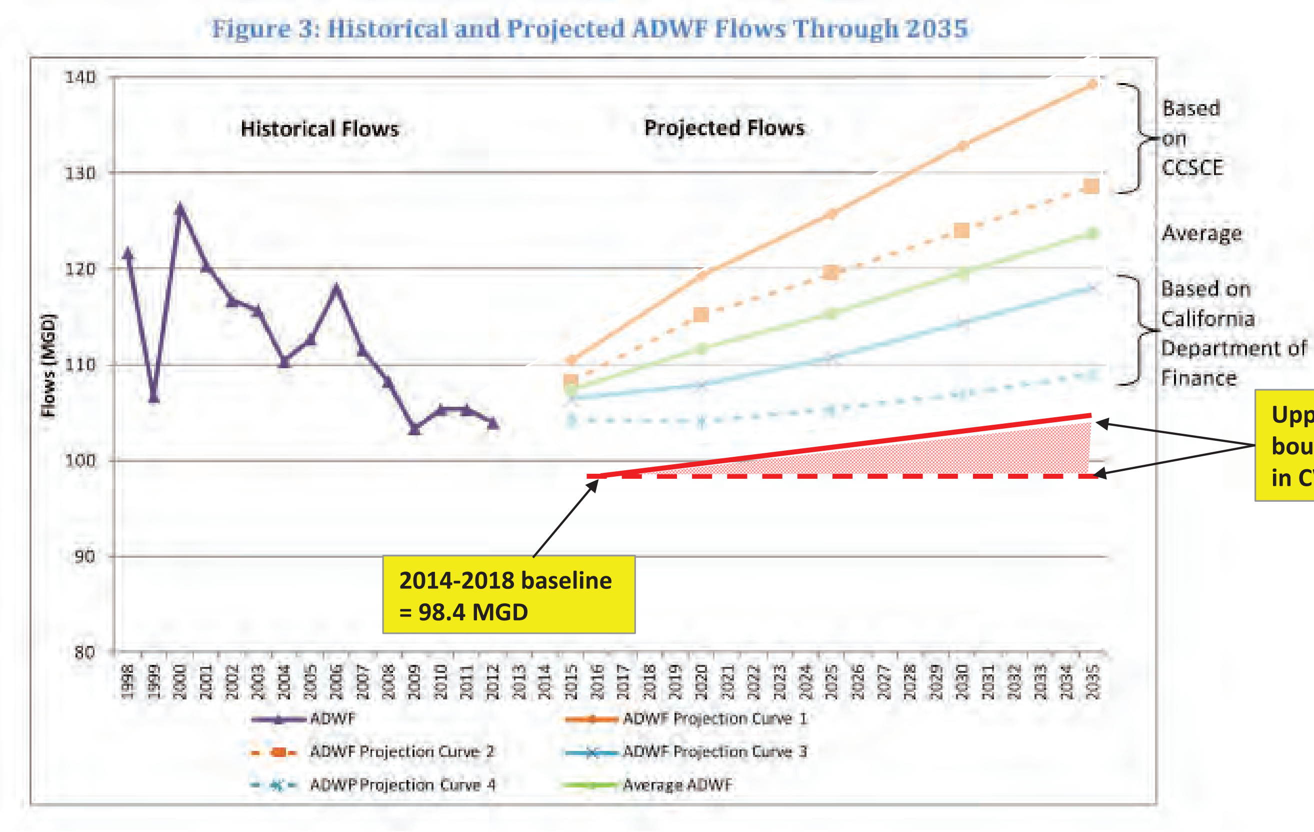
SJ/SC RWF Influent
Average Daily Flows, 2014 through mid-2019

- Range: 68-191 mgd, with 90% of days between 90-120 mgd
- 95% of daily flows exceeded 90 mgd
- **99.9% of daily flows exceeded 80 mgd**



SJ/SC RWF Influent
Future Projections – based on SBWR Strategic and Master Planning Report

1) Started with SBWR report
2) Adjusted downward to reflect lower flow conditions, based on 2014-2018 actuals and assuming same rate of increase (solid red line)
3) Estimated lower bound assuming no flow increase (dashed red line)



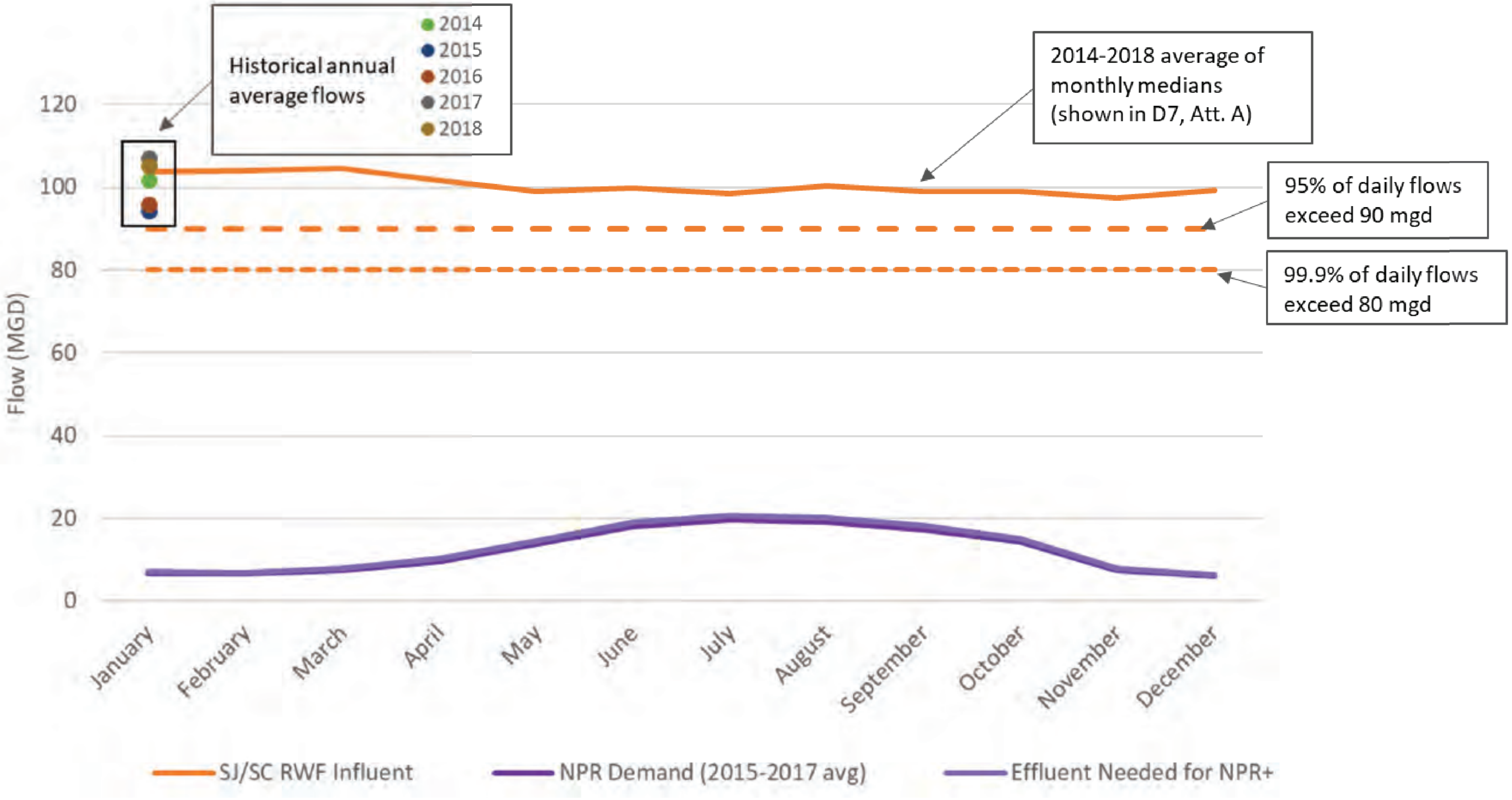
Upper & lower bounds considered in CWRMP

2014-2018 baseline = 98.4 MGD

ADWF = average dry weather flow (lowest consecutive 3-month average)

SJ/SC RWF Flows – Existing Conditions

Based on actual influent flow data (2014-2018) and NPR production (2015-2017)



Historical annual average flows

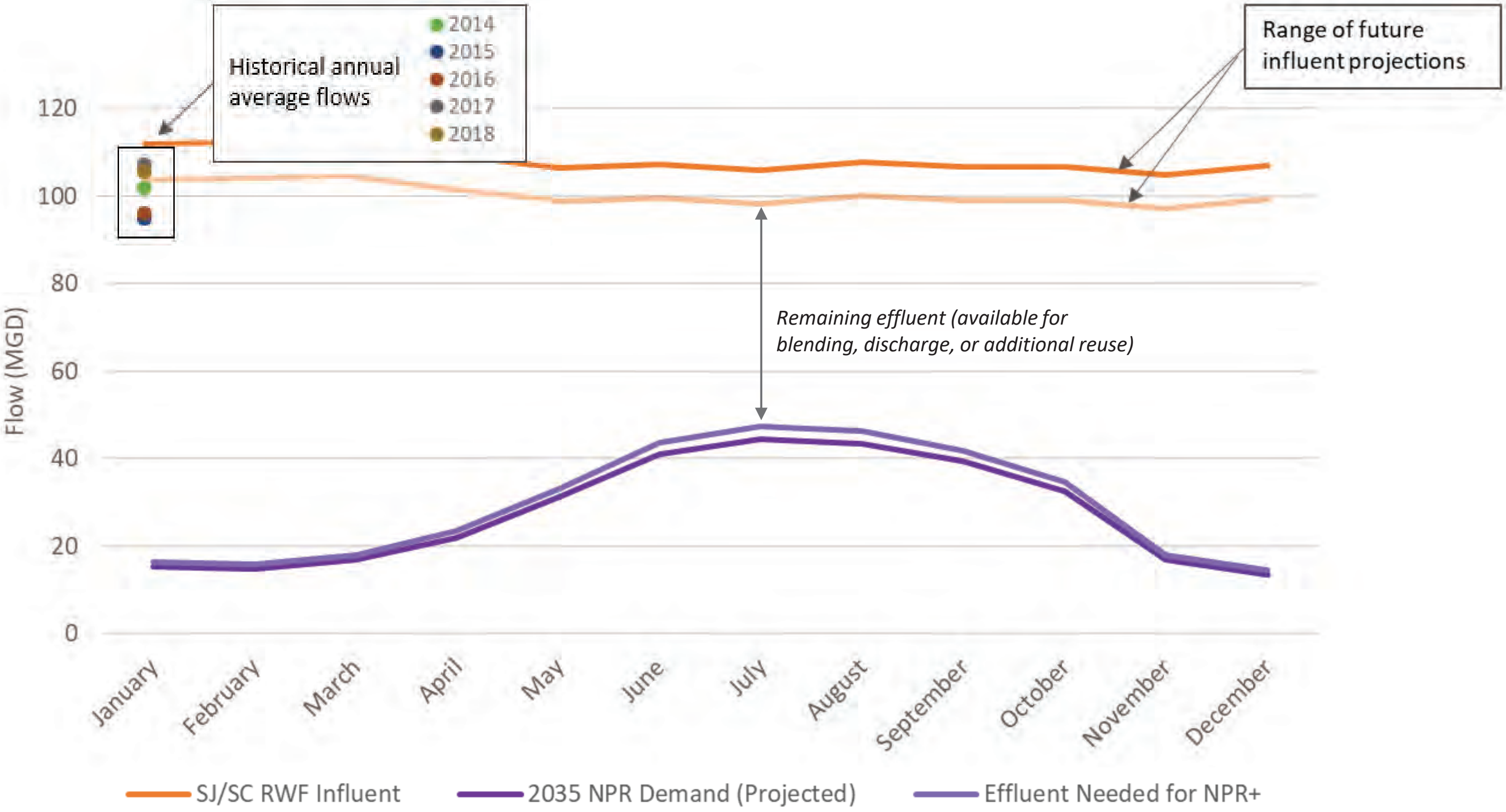
2014-2018 average of monthly medians (shown in D7, Att. A)

95% of daily flows exceed 90 mgd

99.9% of daily flows exceed 80 mgd

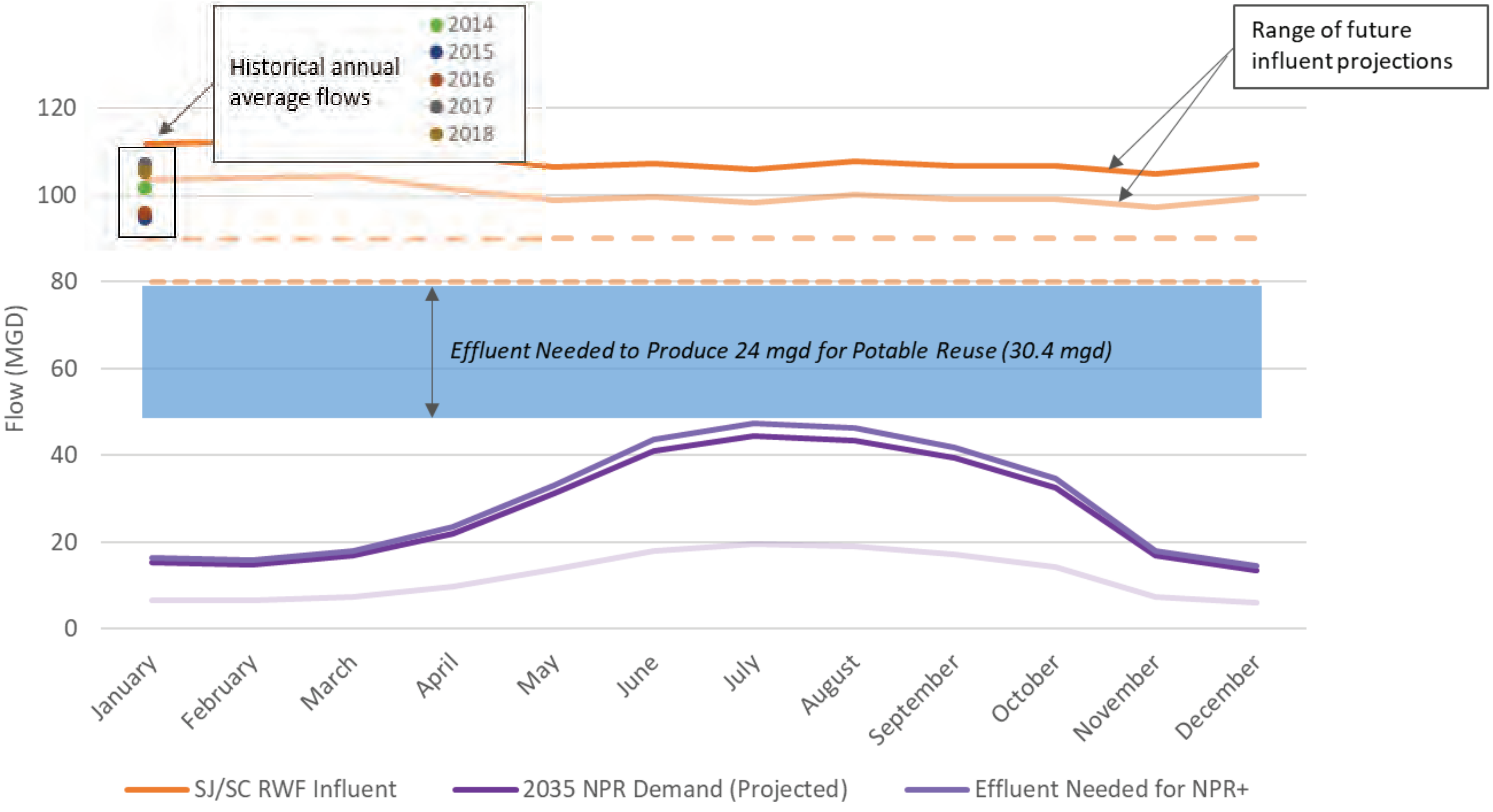
SJ/SC RWF Flows – Future Conditions (2035 Projections)

- Lower bound of future influent assumes flows remain the same as current conditions; upper bound assumes flows increase at rate projected in SBWR Strategic and Master Planning Report
- NPR projections provided by Henry Louie (1/2/19 email)



SJ/SC RWF Flows – Various Scenarios

- 2035 projections show sufficient effluent available to feed a 24 mgd AWPF for potable reuse, even during summer months under “worst” conditions
- Instantaneous peaks or dips will be managed through flow equalization



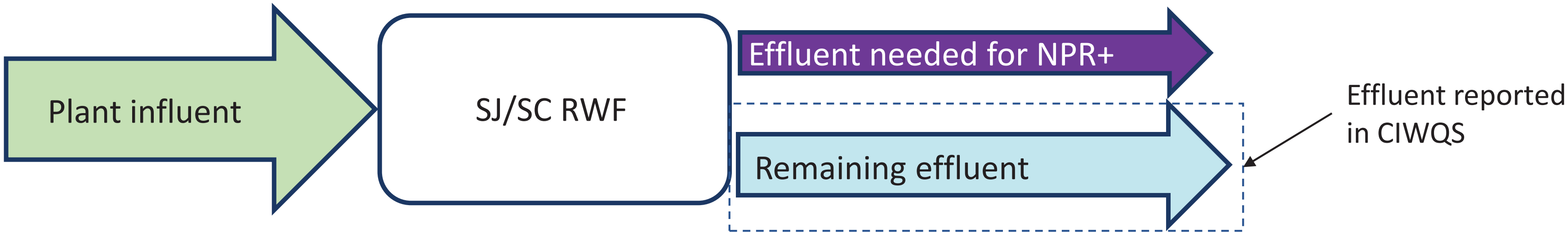
Historical annual average flows

Range of future influent projections

Effluent Needed to Produce 24 mgd for Potable Reuse (30.4 mgd)

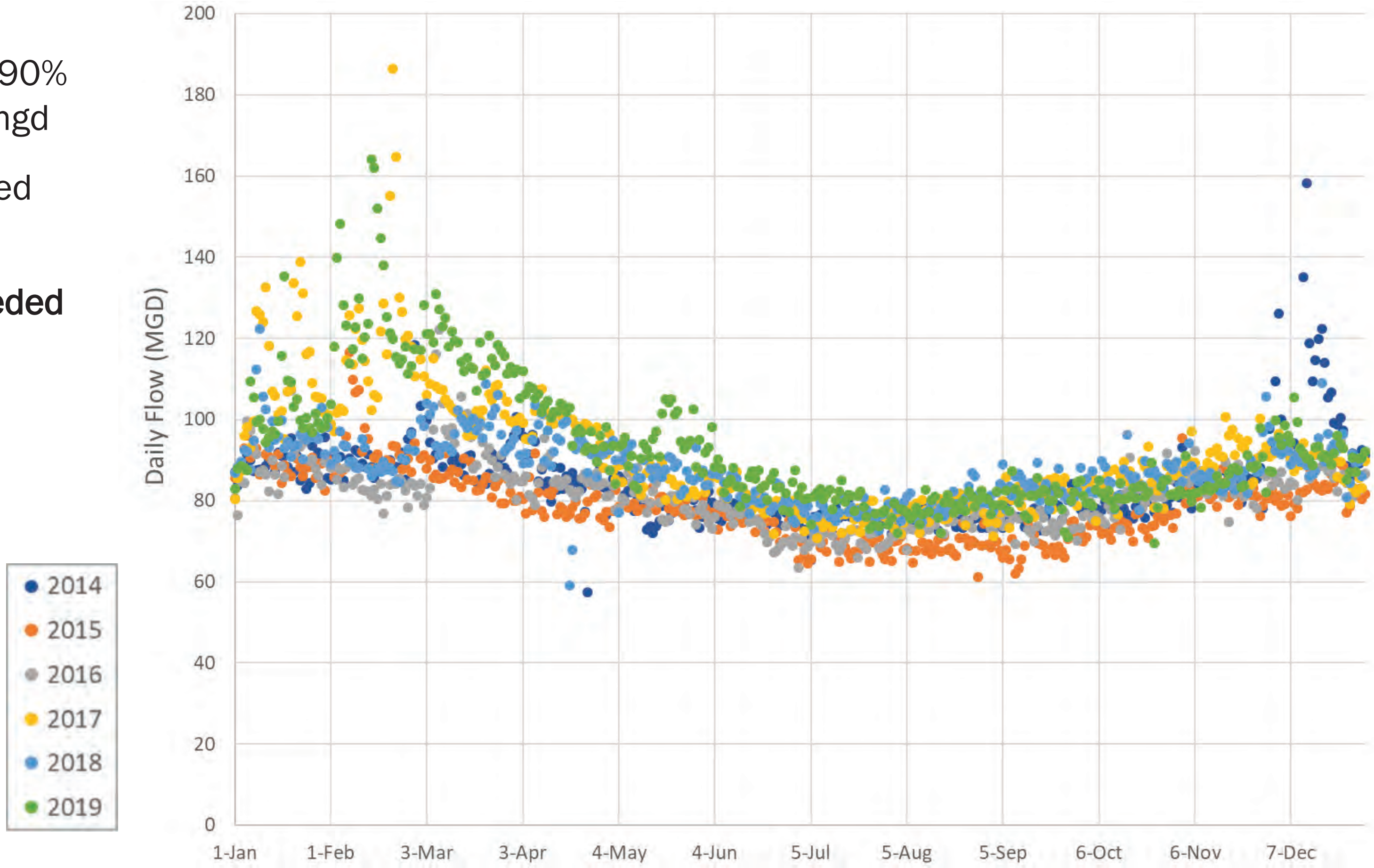
Part 2 – Effluent Analysis

- Uses historical effluent data to determine baseline conditions.
  - Note: Effluent (as reported in CIWQS) is measured as flow discharged to the outfall (i.e., after some effluent is diverted to SVAWPC). Therefore, effluent is approximately equal to *influent minus effluent needed for NPR+* (and other potential losses)
- To estimate future effluent, projected additional NPR demand is subtracted out from current effluent flows.



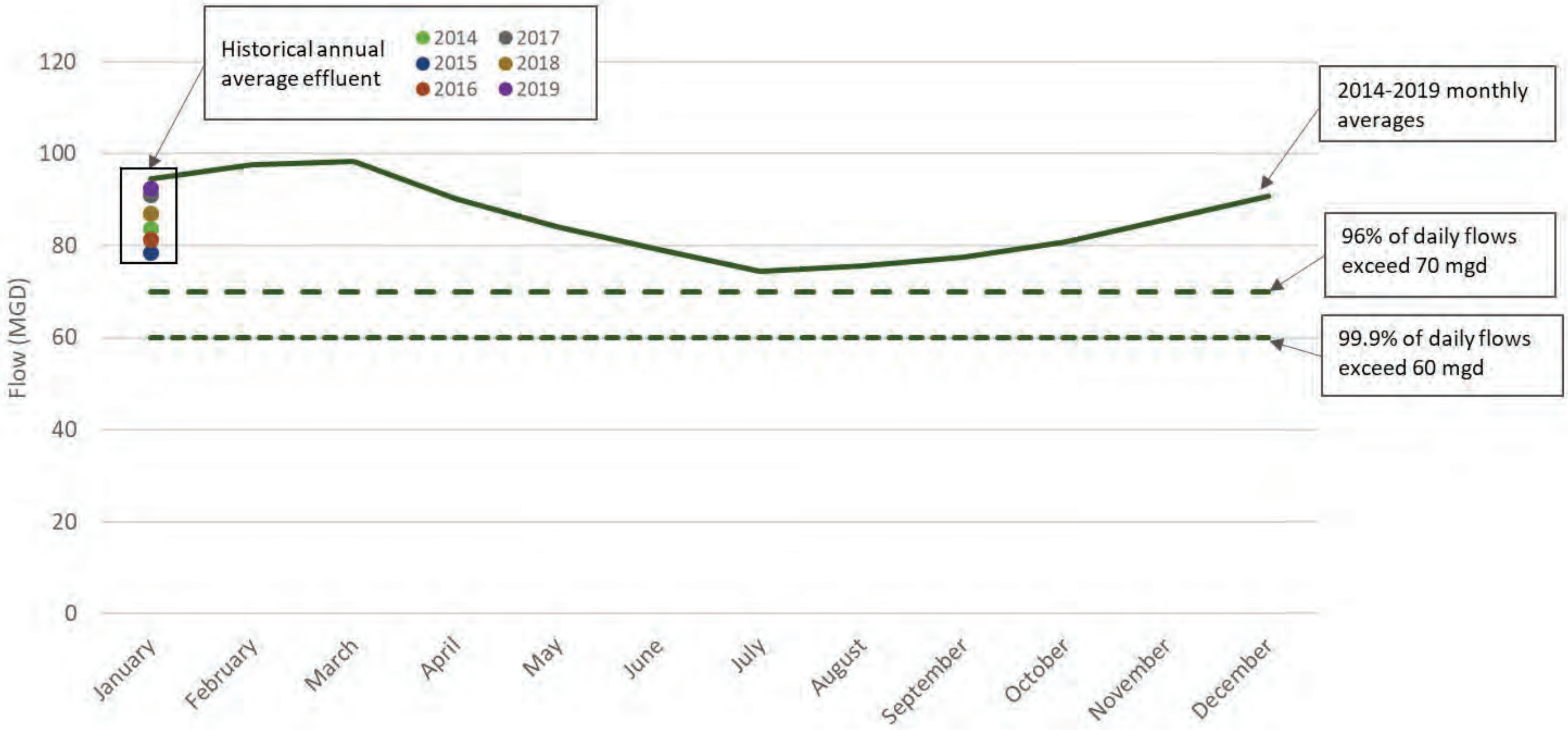
SJ/SC RWF Effluent
Average Daily Flows, 2014 through 2019

- Range: 57-186 mgd, with 90% of days between 70-110 mgd
- 96% of daily flows exceeded 70 mgd
- **99.9% of daily flows exceeded 60 mgd**



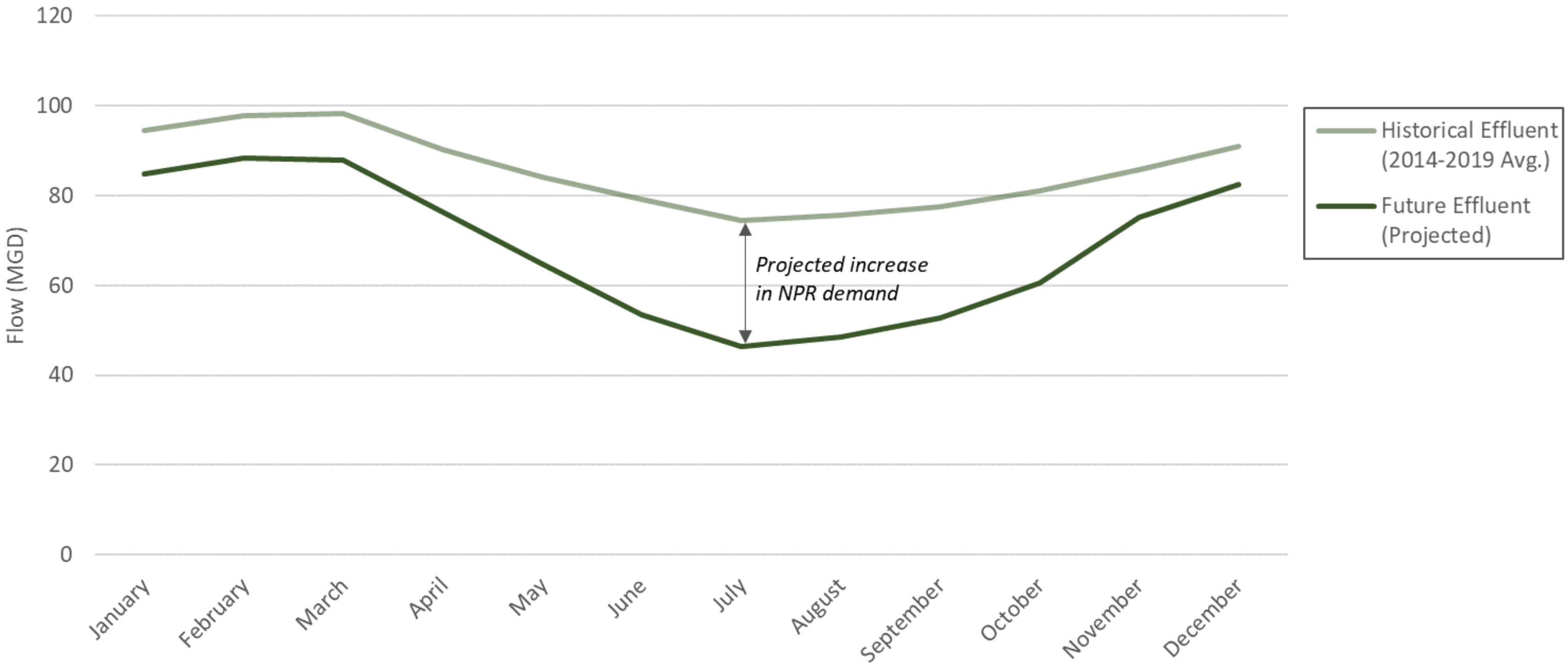
SJ/SC RWF Effluent – Existing Conditions

Based on historical effluent flow data (2014-2019)



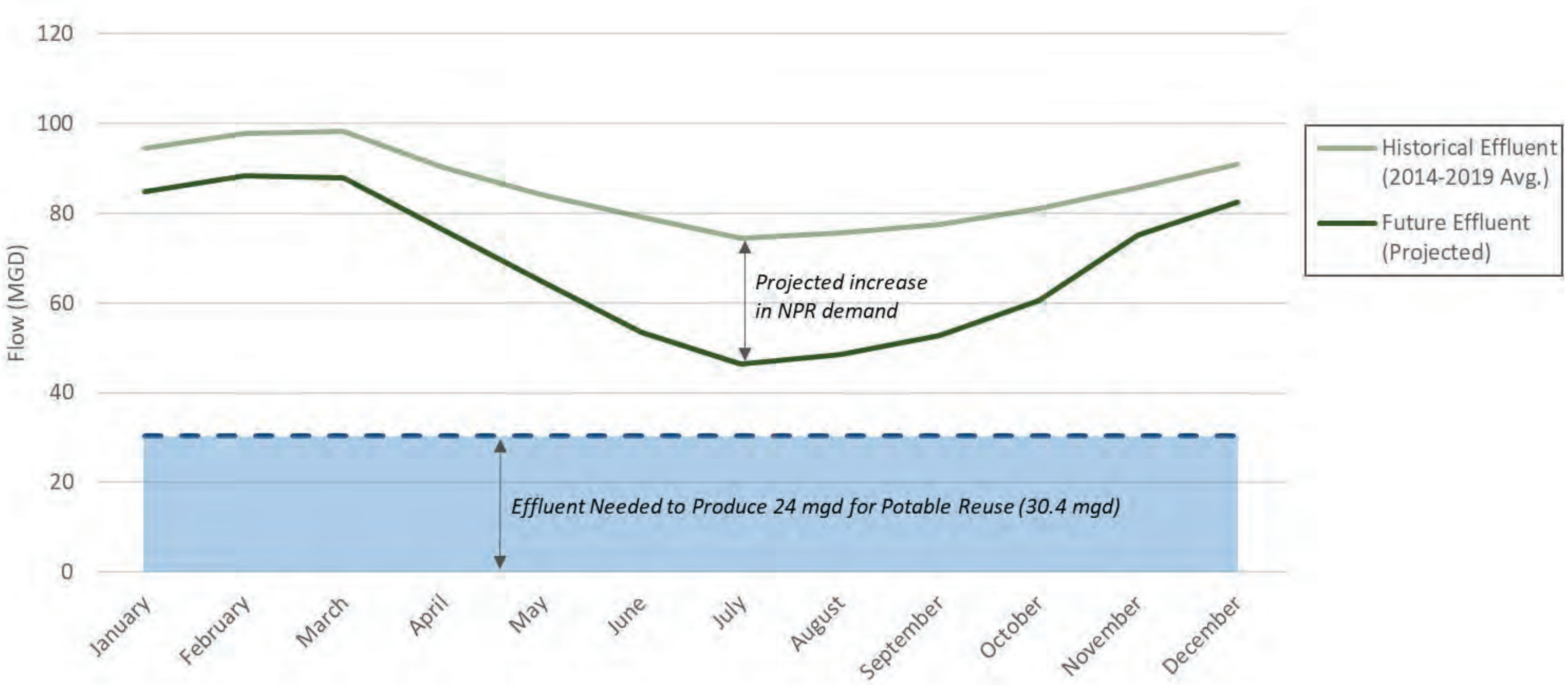
SJ/SC RWF Effluent – Projected Future Conditions

Assumes no increase in future influent, and increased NPR demands at level provided by Henry Louie (1/2/19 email)



SJ/SC RWF Effluent – Projected Future Conditions

- Assumes no increase in future influent, and increased NPR demands at level provided by Henry Louie (1/2/19 email)
- Projections show sufficient effluent available to feed a 24 mgd AWPF for potable reuse year-round



Conclusions

- The plant is designed to capture flows that are generally available.
- Design criteria for a potential new AWPF assume 90% online factor—that is, the plant is not expected to produce 24 mgd, 365 days/year—with equalization to manage instantaneous flow reductions.
- Effluent availability is sufficient to produce 24 mgd of purified water for potable reuse year-round.
    - ➢On most days (99.9%), excess flow is available.
    - ➢Infrequently (<0.1% of days), flows are too low to produce 24 mgd of purified water.

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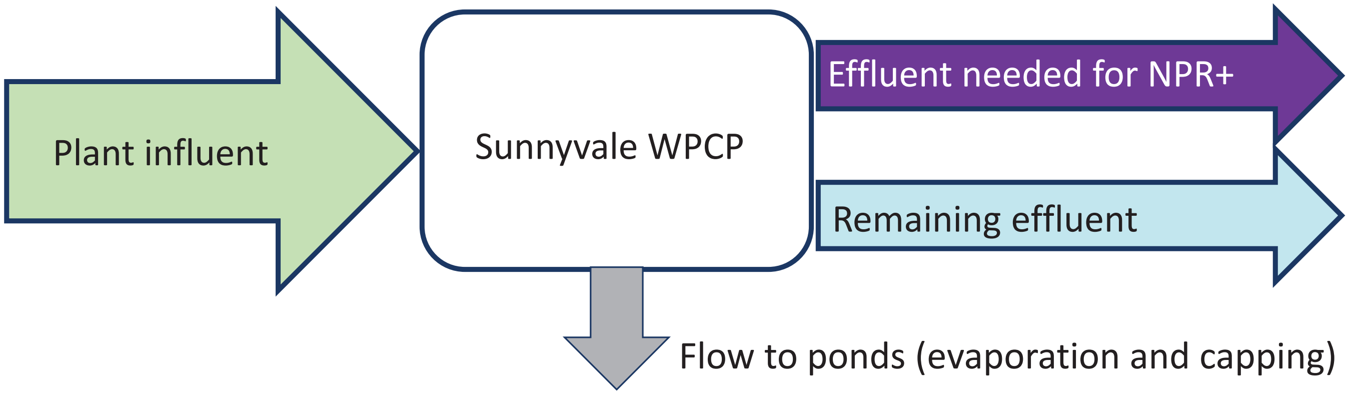
Sunnyvale WPCP

Historical and Projected Future Flow Conditions

June 24, 2020

Part 1 – Influent Analysis

- Uses future influent, NPR demand projections, and losses associated with treatment ponds to estimate remaining effluent available (assuming partial or full conversion to conventional activated sludge).
- Considers a range of future influent flows, using 2014-2018 influent data (downloaded from CIWQS*) to determine baseline conditions.
  - ➢Conservative estimate (lower bound) assumes no increase in influent



Plant influent

Sunnyvale WPCP

Effluent needed for NPR+

Remaining effluent

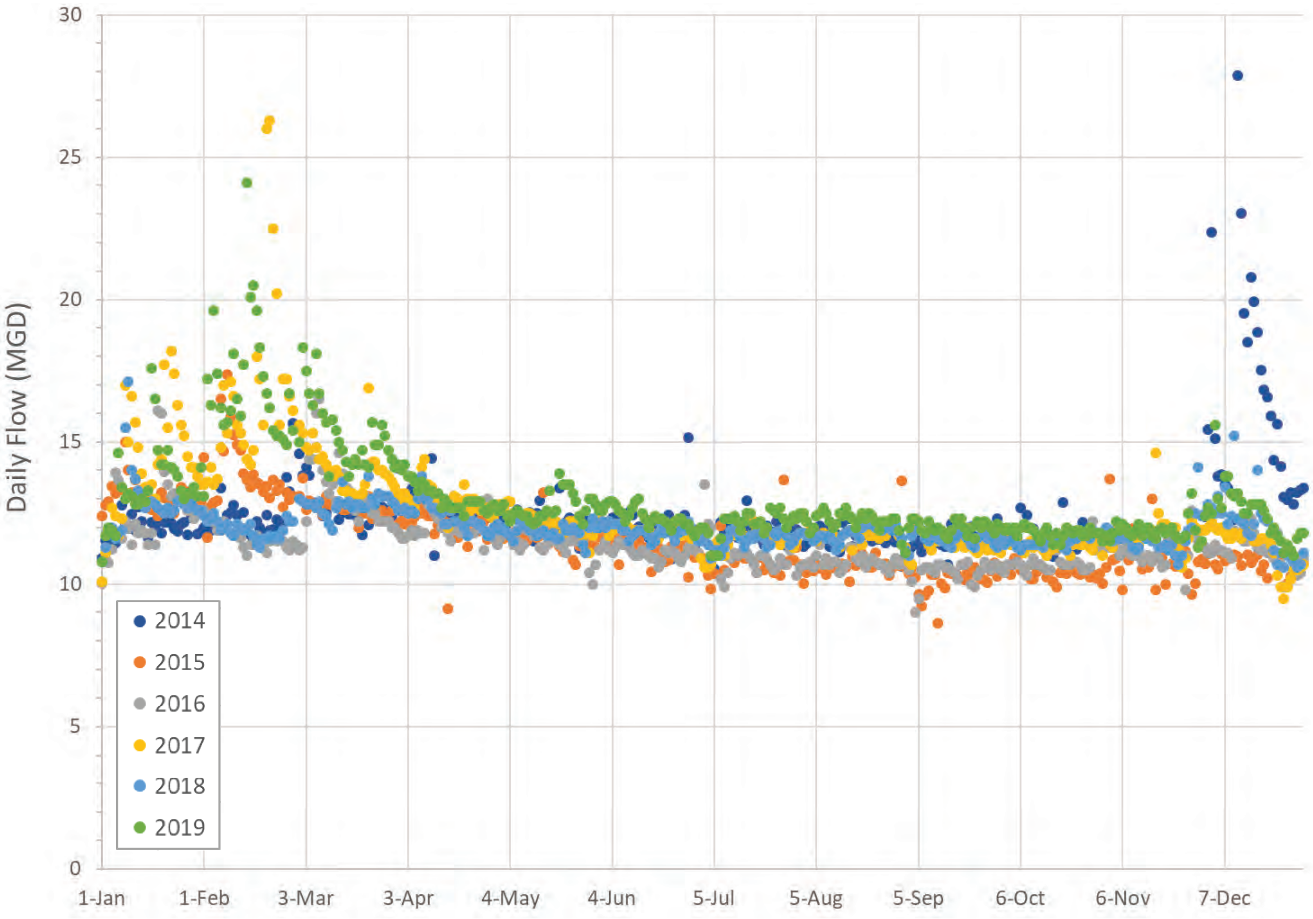
Flow to ponds (evaporation and capping)

*Per Sunnyvale staff, influent flows were reduced by 0.5 mgd from CIWQS eSMR Analytical Report: http://ciwqs.waterboards.ca.gov/ciwqs/readOnly/CiwqsReportServlet?inCommand=reset&reportName=esmrAnalytical

Sunnyvale WPCP Influent
Average Daily Flows, 2014 through 2019

- Range: 8.6 to 28 mgd
- 99% of daily flows exceeded 10 mgd

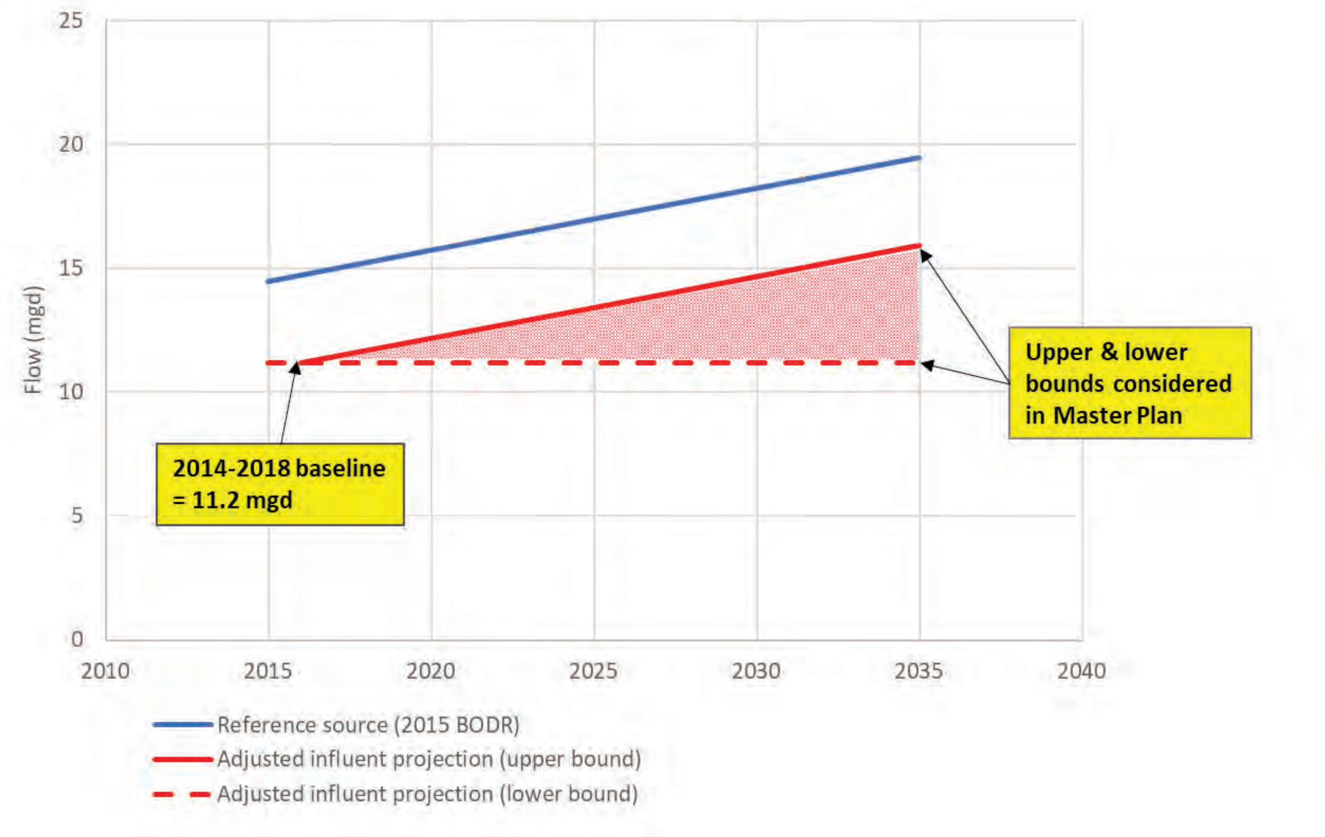
NOTE: Per Sunnyvale staff, actual Sunnyvale WPCP influent is ~0.5 mgd lower than the values reported in CIWQS, due to a difference in metering location. To account for this, the figure to the right (and the rest of the flow analysis) adjusts CIWQS values down by 0.5 mgd.



Sunnyvale WPCP Influent
Future ADWF Projections – based on Sunnyvale WPCP BODR

1) Started with 2015 BODR – *Simultaneous Production of Recycled Water: WPCP*
2) Adjusted downward to reflect lower flow conditions, based on 2014-2018 actuals and assuming same rate of increase (solid red line)
3) Estimated lower bound assuming no flow increase (dashed red line)

ADWF = average dry weather flow (lowest consecutive 3-month average)

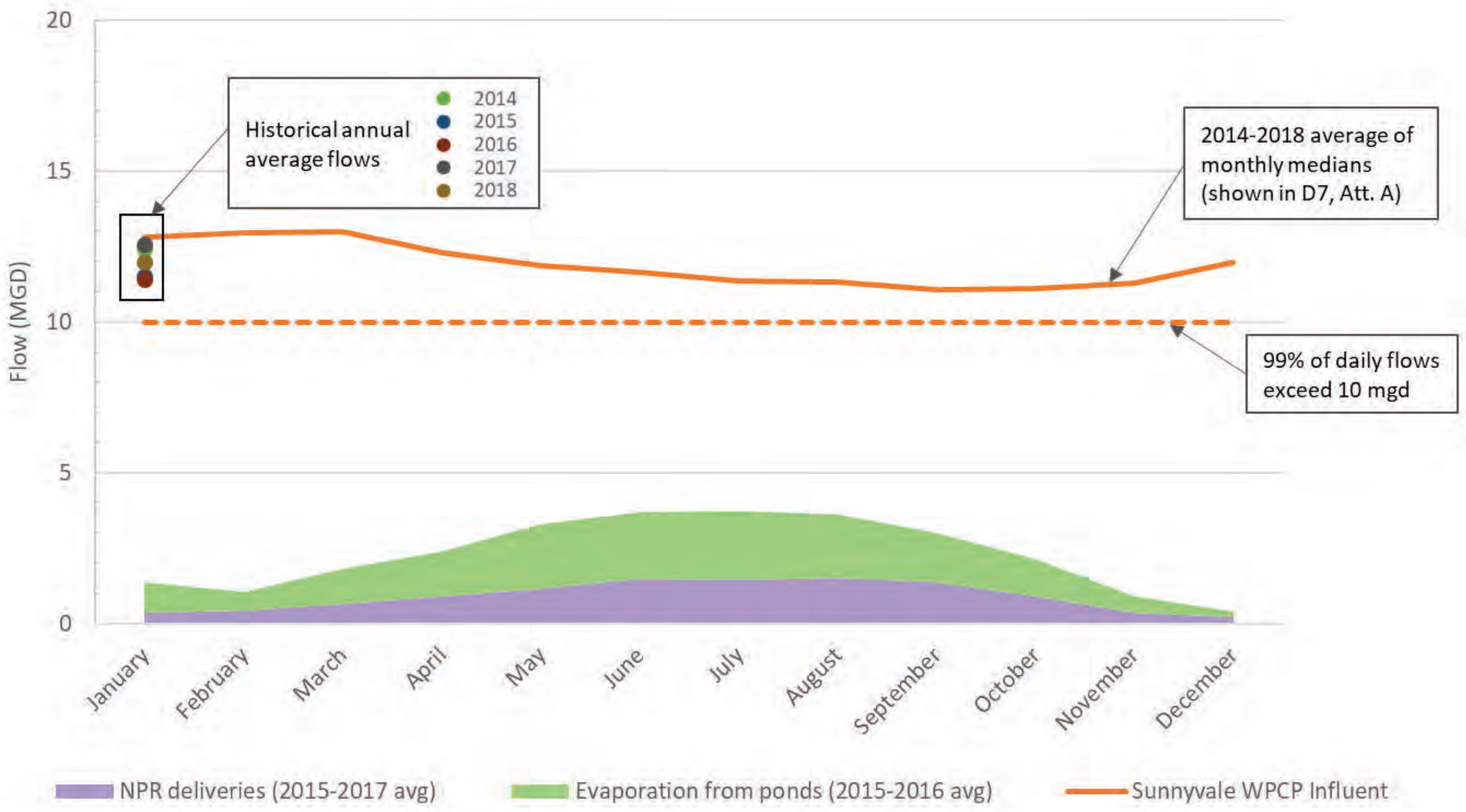


2014-2018 baseline = 11.2 mgd

Upper & lower bounds considered in Master Plan

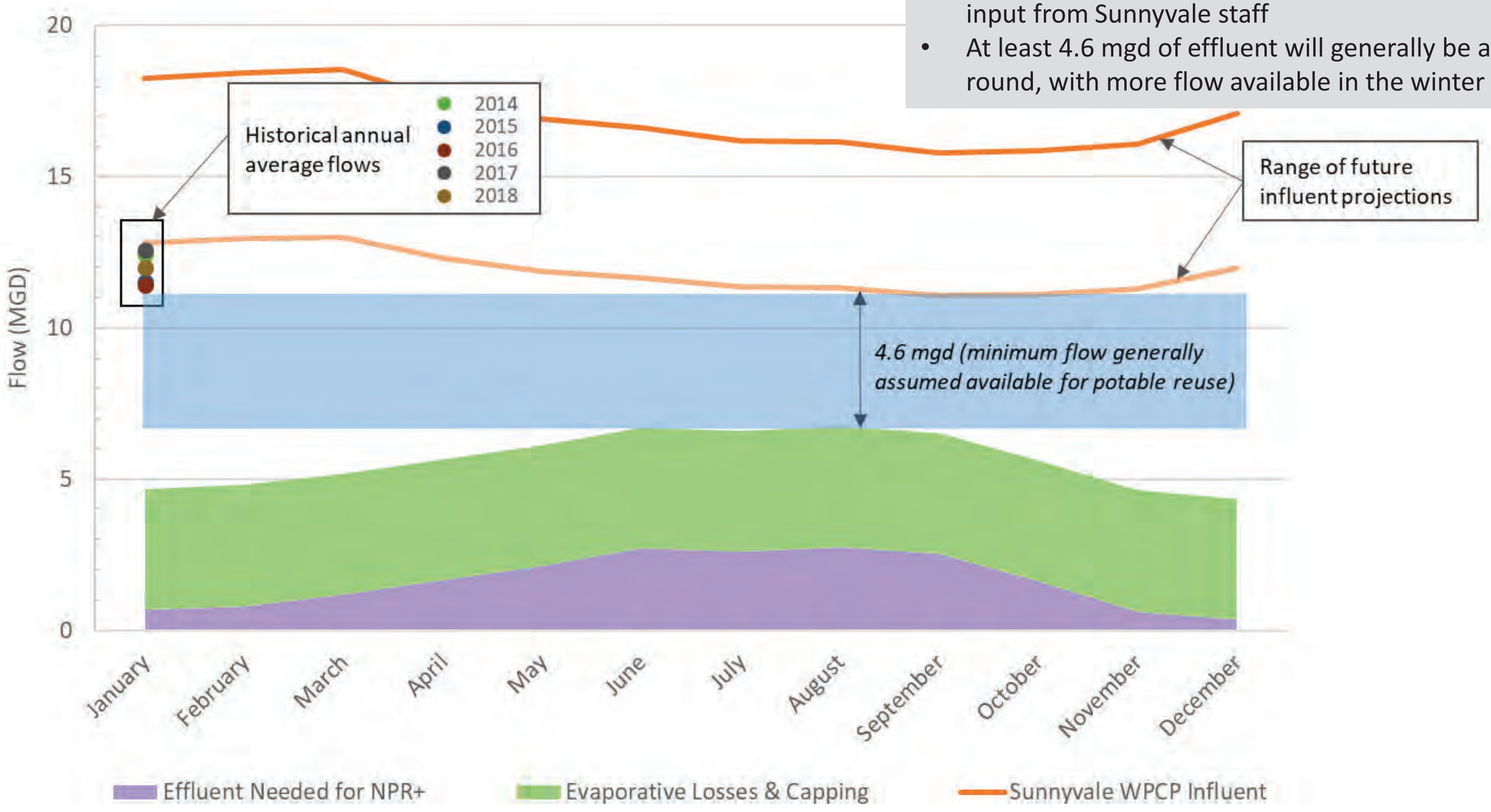
Sunnyvale WPCP Flows – Existing Conditions

- Based on influent flow data from CIWQS (2014-2018) reduced by 0.5 mgd per Sunnyvale staff
- Based on NPR delivery data (2015-2017) and pond evaporation data (2015-2016) provided by Sunnyvale staff



Sunnyvale WPCP Flows – Future Conditions (2035 Projections)

- Lower bound of future influent assumes flows remain the same as current conditions; upper bound assumes flows increase at rate projected in Sunnyvale WPCP BODR
- NPR projections from Sunnyvale's 2015 UWMP; includes additional flow required for NPR+ (i.e., ROC losses)
- Assumes 4 mgd to ponds for evaporation and capping, per input from Sunnyvale staff
- At least 4.6 mgd of effluent will generally be available year-round, with more flow available in the winter months.



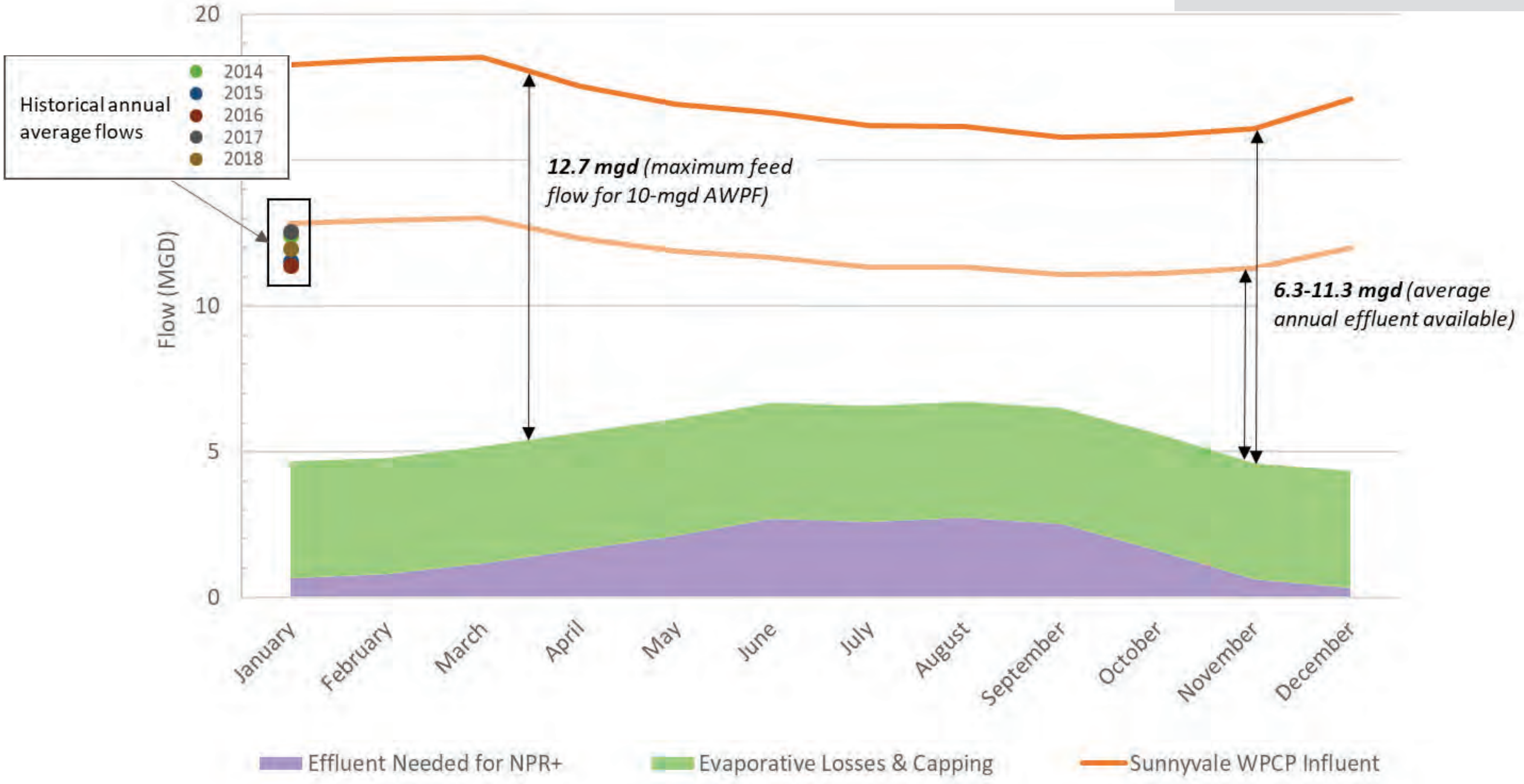
Historical annual average flows

Range of future influent projections

4.6 mgd (minimum flow generally assumed available for potable reuse)

Sunnyvale WPCP Flows – Future Conditions (2035 Projections)

- Average effluent assumed available for reuse is 6.3-11.3 mgd
- The maximum source flow for a 10-mgd AWPF is 12.7 mgd - likely only available if upper bound of influent is reached AND/OR treatment ponds are removed (reducing evaporative losses & capping)

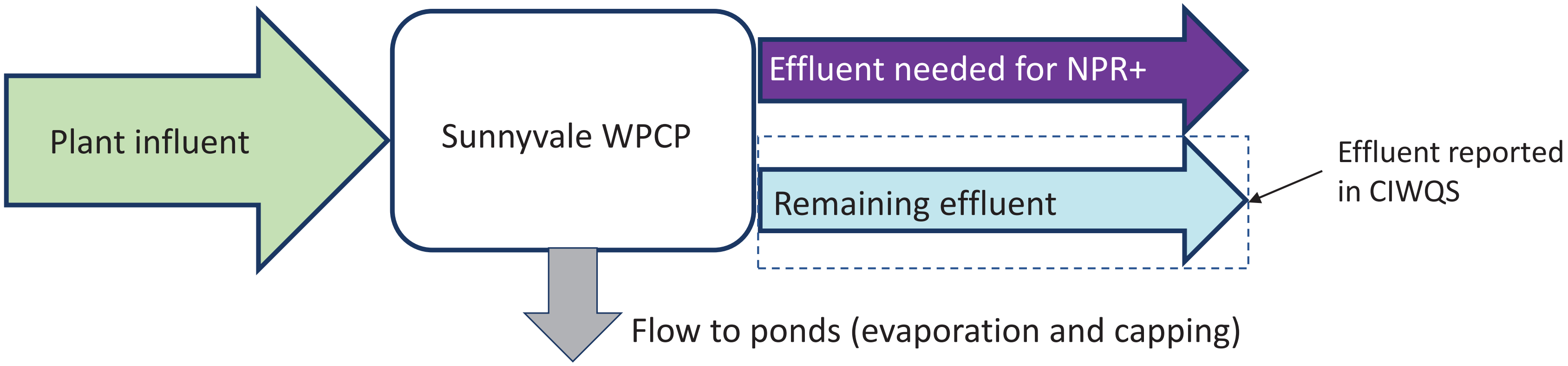


12.7 mgd *(maximum feed flow for 10-mgd AWPF)*

6.3-11.3 mgd *(average annual effluent available)*

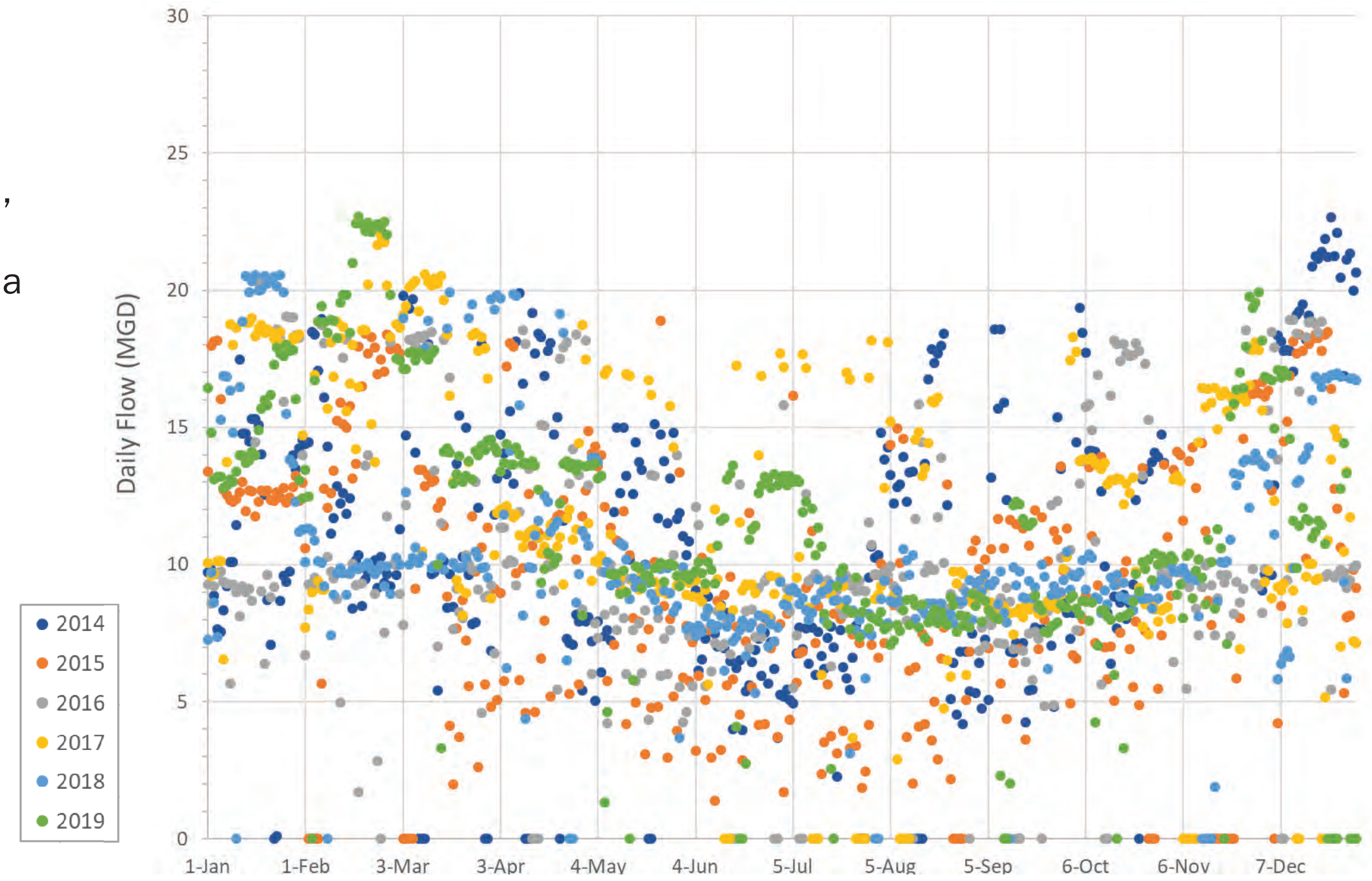
Part 2 – Effluent Analysis

- Uses historical effluent data to determine baseline conditions (assuming the secondary treatment process is **not** converted to activated sludge).
  - ➢Effluent (as reported in CIWQS) is measured as flow discharged to the outfall (i.e., after some effluent is diverted for NPR and lost through the ponds).
  - ➢Due to the batch treatment system, effluent flow is extremely variable. Flow availability must be evaluated over longer periods of time (e.g., monthly)
- To estimate future effluent, projected additional NPR demand is subtracted out from current effluent flows.



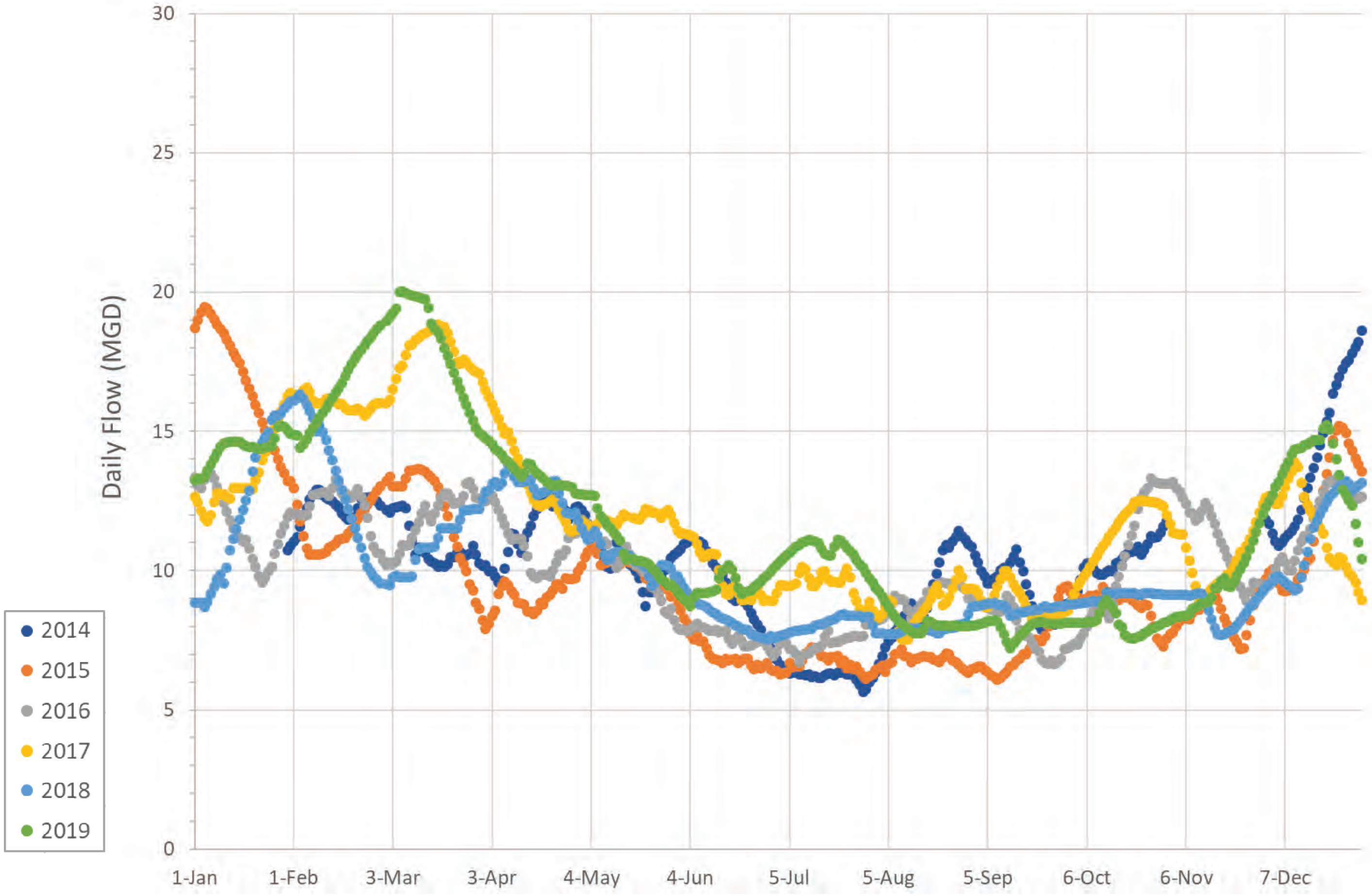
Sunnyvale WPCP Effluent
Average Daily Flows, 2014 through 2019

- Range: 0 to 22.7 mgd
- NOTE: In Sunnyvale's current treatment system, effluent is released in batches (i.e., there is not a constant stream of flow).



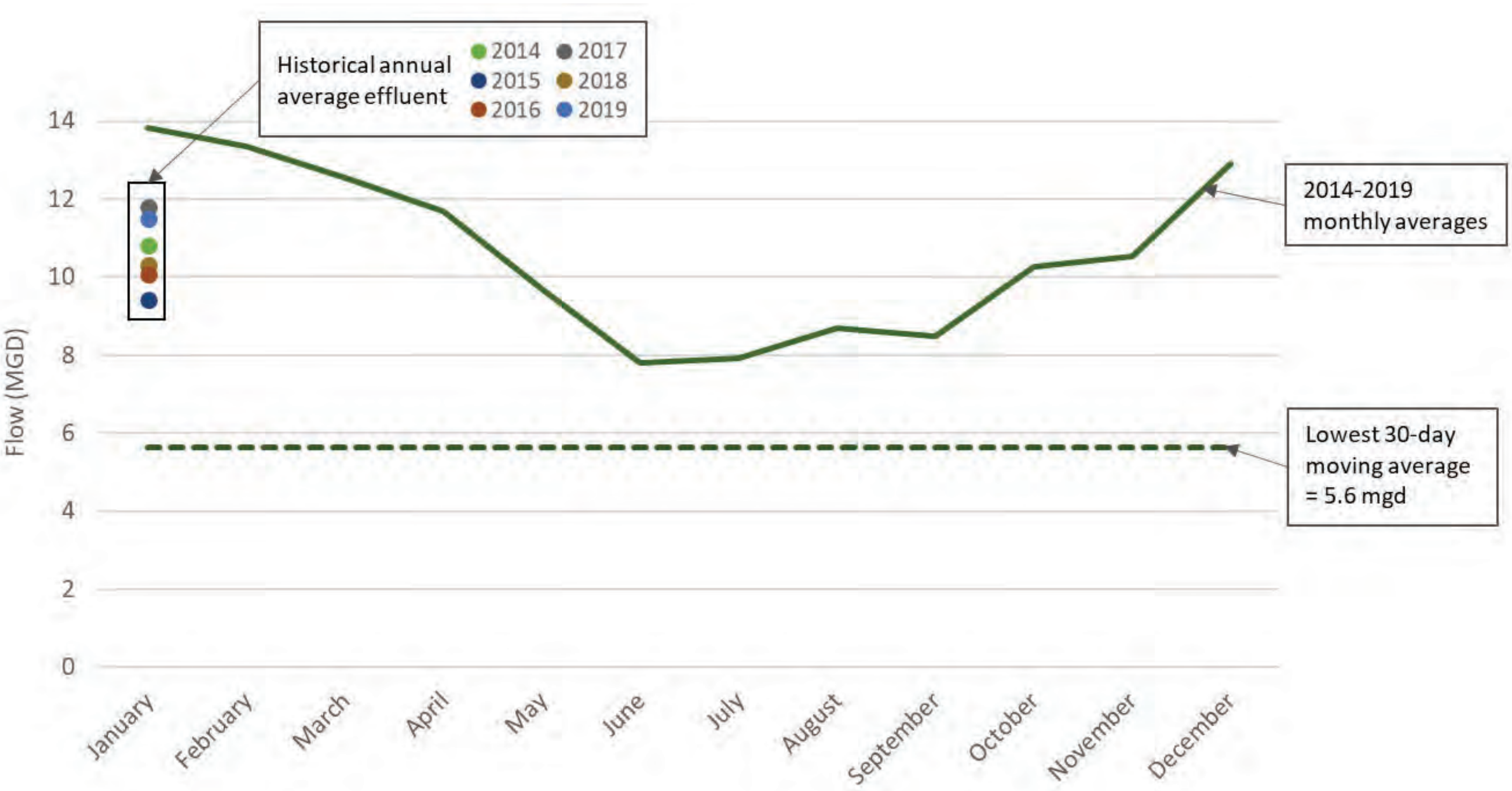
Sunnyvale WPCP Effluent
30-Day Moving Average, 2014 through 2019

- Range: 5.6 to 20 mgd
- >99% of 30-day averages exceeded 6 mgd



Sunnyvale WPCP Effluent – Existing Conditions

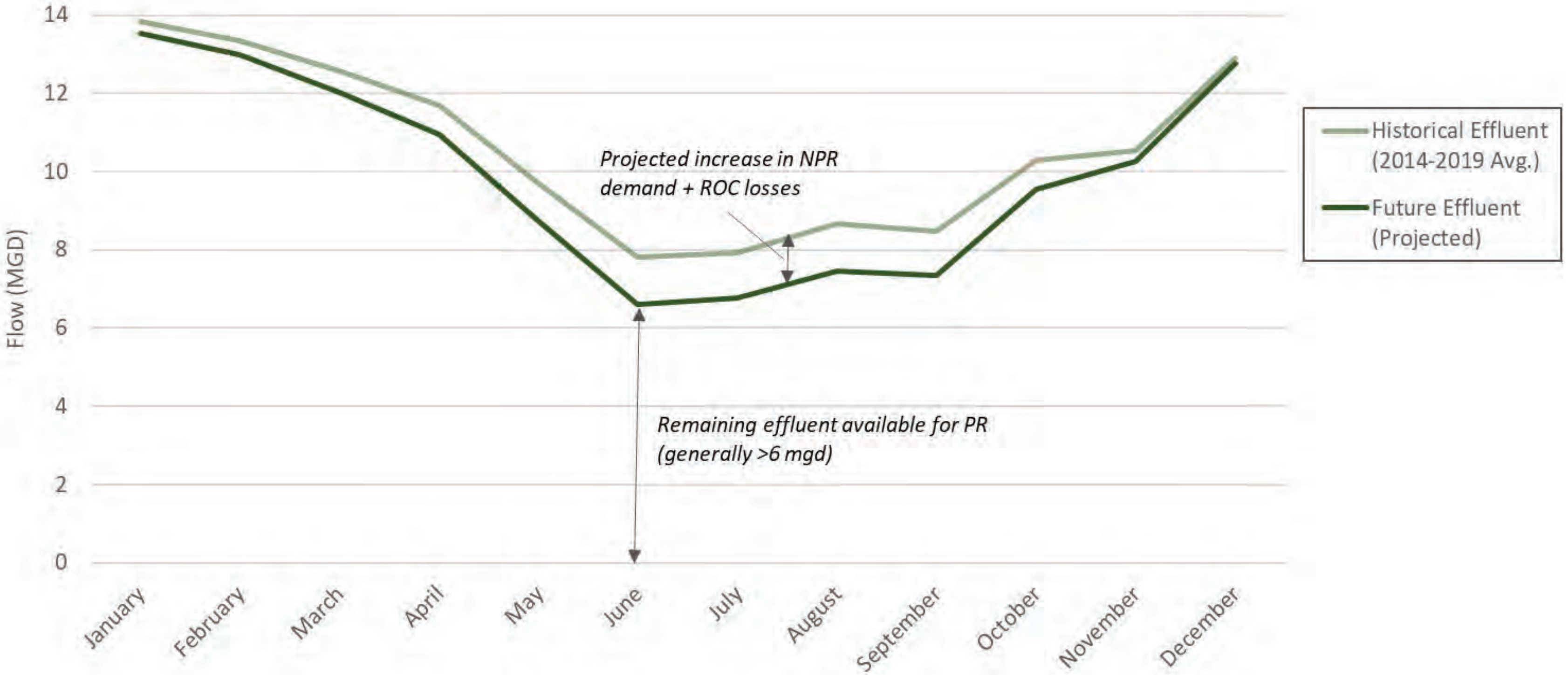
Based on historical effluent flow data (2014-2019)



Sunnyvale WPCP Effluent – Projected Future Conditions

Assumes:

- No increase in future influent
- No changes to treatment ponds
- NPR demand increases at level projected in 2015 UWMP
- Includes ROC losses associated with NPR+



Projected increase in NPR demand + ROC losses

Remaining effluent available for PR (generally >6 mgd)

Conclusions

- Sunnyvale's batch treatment system results in irregular effluent discharge (some days, zero effluent is discharged). Changes that would allow an AWPF to operate with consistent flow include:
  - Partial or full conversion to conventional activated sludge (CAS). Phase 1 CAS (split flow) is currently in design.
  - Reoperation of the ponds, such that days of zero effluent discharge are staggered and predictable (which could be managed through equalization storage)
- On average, at least 5 mgd of effluent is generally available, with larger flows available in winter months.
- The potential new 10-mgd AWPF was sized to capture higher winter flows (max. feed flow = 12.7 mgd), though will not operate at full capacity year-round (expected efficiency 80-90%).

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Attachment B: Monthly Flows by Partner Agency

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Table B-1. Palo Alto Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield

2035 Flows, Upper Bound:

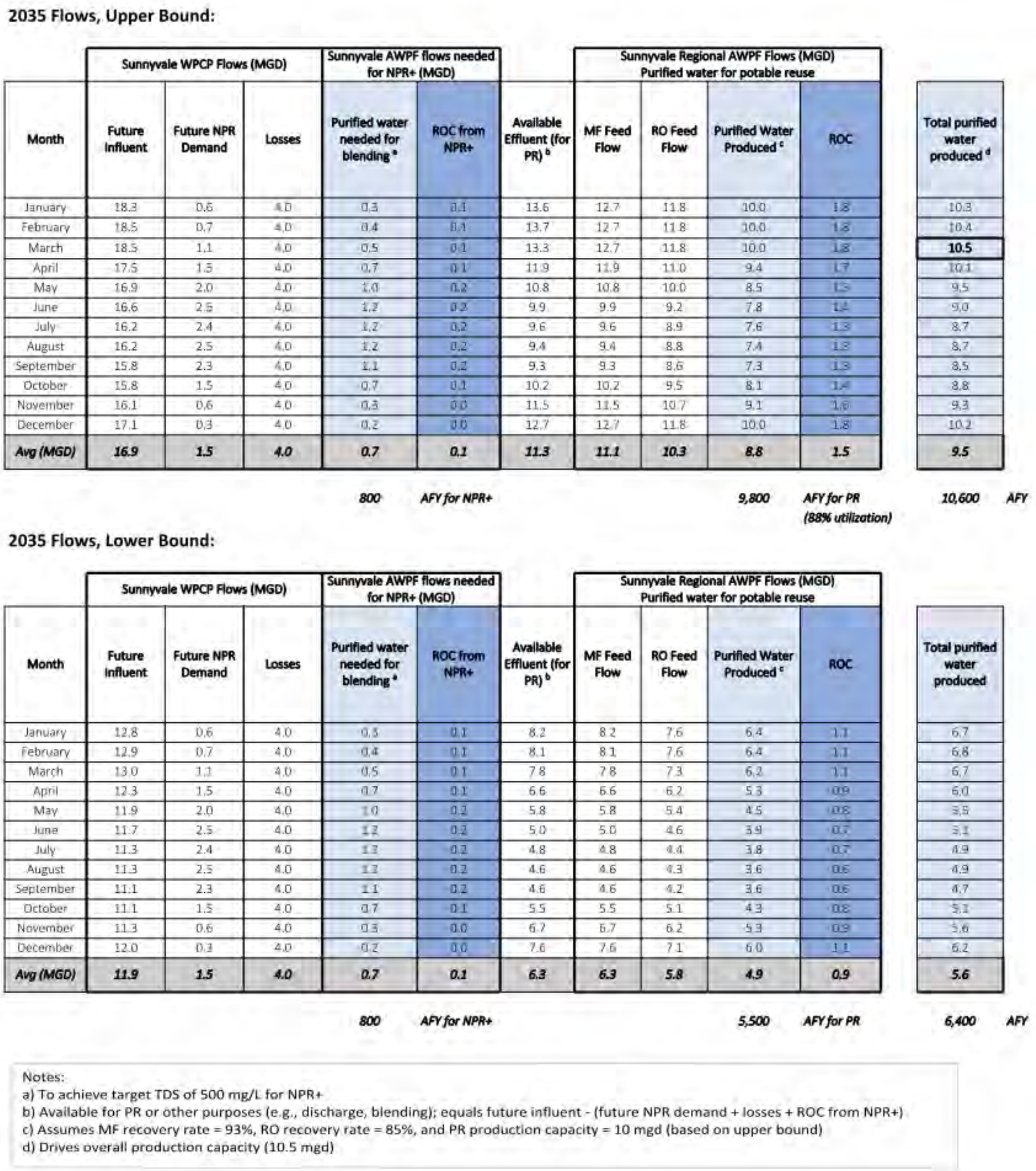
	Palo Alto RWQCP Flows (MGD)			Local AWPF flows for NPR+ (MGD) [a]			Palo Alto Regional AWPF Flows (MGD) Purified water for potable reuse			
Month	**Future Influent**	**Future NPR Demand**	**Renzel Marsh flow + losses**	**Purified water needed for blending**	**ROC from NPR+**	**Available Effluent (for PR) [b]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [c]**	**ROC**
January	23.3	0.5	3.3	0.2	0.0	19.5	17.7	16.5	14.0	**2.5**
February	24.3	0.7	3.3	0.3	0.1	20.2	17.7	16.5	14.0	**2.5**
March	23.9	1.1	3.3	0.5	0.1	19.4	17.7	16.5	14.0	**2.5**
April	22.6	2.1	3.3	0.9	0.2	17.0	17.0	15.8	13.5	**2.4**
May	21.8	3.5	3.3	1.5	0.3	14.6	14.6	13.6	11.6	**2.0**
June	21.1	4.4	3.3	1.9	0.3	13.1	13.1	12.2	10.3	**1.8**
July	19.8	4.5	3.3	2.0	0.3	11.7	11.7	10.8	9.2	**1.6**
August	19.7	4.9	3.3	2.1	0.4	11.1	11.1	10.4	8.8	**1.6**
September	19.4	4.0	3.3	1.7	0.3	11.8	11.8	11.0	9.3	**1.6**
October	19.7	2.8	3.3	1.2	0.2	13.4	13.4	12.5	10.6	**1.9**
November	19.8	0.9	3.3	0.4	0.1	15.6	15.6	14.5	12.3	**2.2**
December	21.1	0.7	3.3	0.3	0.1	17.0	17.0	15.8	13.4	**2.4**
Avg (MGD)	***21.3***	***2.5***	***3.3***	***1.1***	***0.2***	***15.3***	***14.9***	***13.8***	***11.8***	***2.1***
				1,200	***AFY for NPR+***				***13,200***	***AFY for PR (84% utilization)***

2035 Flows, Lower Bound:

	Palo Alto RWQCP Flows (MGD)			Local AWPF flows for NPR+ (MGD) [a]			Palo Alto Regional AWPF Flows (MGD) Purified water for potable reuse			
Month	**Future Influent**	**Future NPR Demand**	**Renzel Marsh flow + losses**	**Purified water needed for blending**	**ROC from NPR+**	**Available Effluent (for PR) [b]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [c]**	**ROC**
January	21.0	0.5	3.3	0.2	0.0	17.2	17.2	16.0	13.6	**2.4**
February	21.9	0.7	3.3	0.3	0.1	17.9	17.7	16.5	14.0	**2.5**
March	21.6	1.1	3.3	0.5	0.1	17.1	17.1	15.9	13.5	**2.4**
April	20.4	2.1	3.3	0.9	0.2	14.8	14.8	13.8	11.7	**2.1**
May	19.7	3.5	3.3	1.5	0.3	12.5	12.5	11.7	9.9	**1.7**
June	19.0	4.4	3.3	1.9	0.3	11.0	11.0	10.3	8.7	**1.5**
July	17.9	4.5	3.3	2.0	0.3	9.7	9.7	9.1	7.7	**1.4**
August	17.8	4.9	3.3	2.1	0.4	9.2	9.2	8.6	7.3	**1.3**
September	17.5	4.0	3.3	1.7	0.3	9.9	9.9	9.2	7.8	**1.4**
October	17.8	2.8	3.3	1.2	0.2	11.5	11.5	10.7	9.1	**1.6**
November	17.9	0.9	3.3	0.4	0.1	13.6	13.6	12.7	10.8	**1.9**
December	19.0	0.7	3.3	0.3	0.1	15.0	15.0	13.9	11.8	**2.1**
Avg (MGD)	***19.3***	***2.5***	***3.3***	***1.1***	***0.2***	***13.3***	***13.3***	***12.3***	***10.5***	***1.9***
				1,200	***AFY for NPR+***				***11,700***	***AFY for PR***

Notes:
a) Separate local AWPF for NPR+ in Palo Alto already planned
b) Available for PR or other purposes (e.g., discharge, blending); equals future influent - (future NPR demand + Renzel Marsh flow + losses + ROC from NPR+)
c) Assumes MF recovery rate = 93%, RO recovery rate = 85%, and PR production capacity = 14 mgd (based on upper bound)

Table B-2. Sunnyvale Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2035 Flows, Upper Bound:

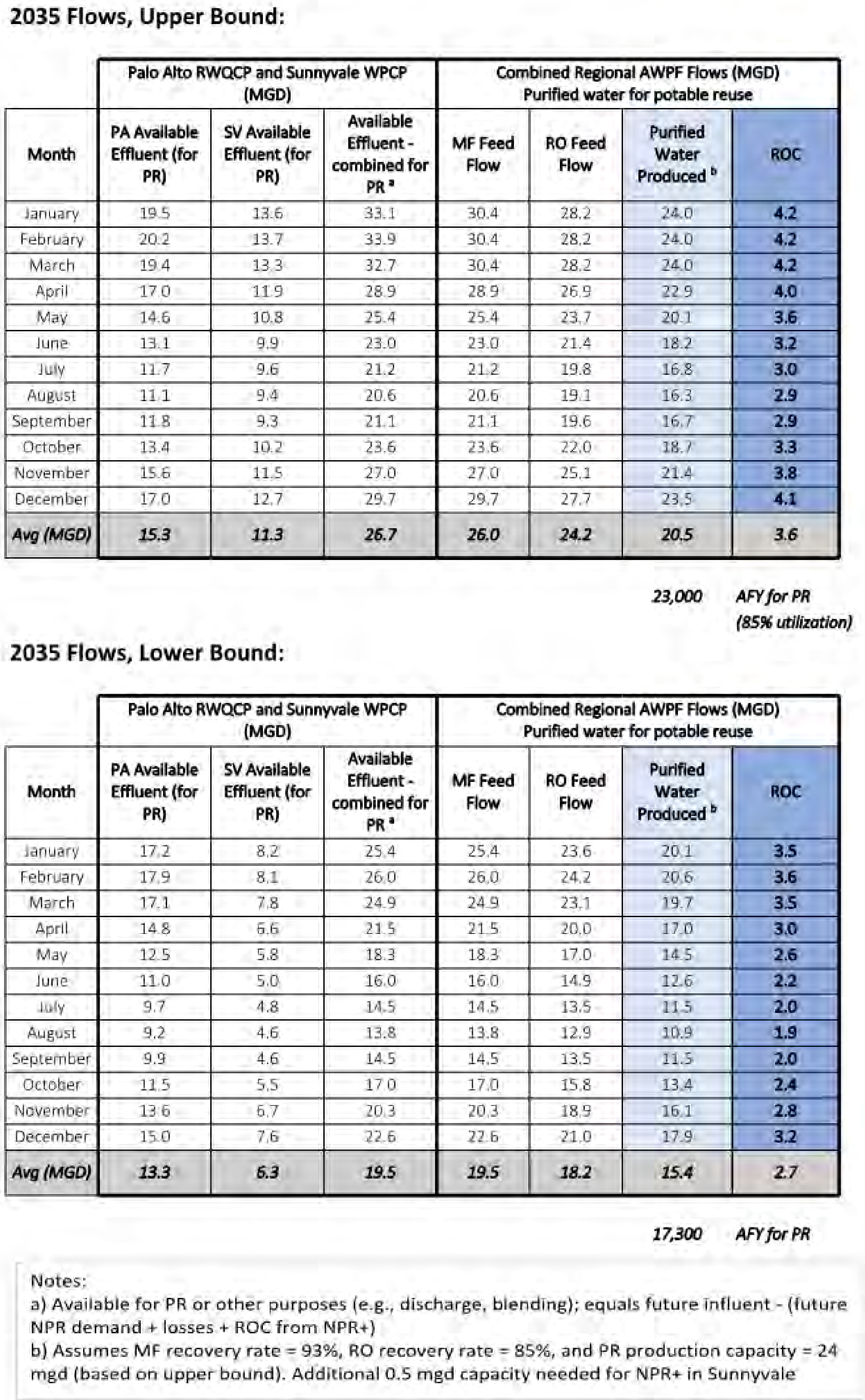
	Sunnyvale WPCP Flows (MGD)			Sunnyvale AWPF flows needed for NPR+ (MGD)			Sunnyvale Regional AWPF Flows (MGD) Purified water for potable reuse				
Month	**Future Influent**	**Future NPR Demand**	**Losses**	**Purified water needed for blending [a]**	**ROC from NPR+**	**Available Effluent (for PR) [b]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [c]**	**ROC**	**Total purified water produced [d]**
January	18.3	0.6	4.0	0.3	0.1	13.6	12.7	11.8	10.0	1.8	10.3
February	18.5	0.7	4.0	0.4	0.1	13.7	12.7	11.8	10.0	1.8	10.4
March	18.5	1.1	4.0	0.5	0.1	13.3	12.7	11.8	10.0	1.8	**10.5**
April	17.5	1.5	4.0	0.7	0.1	11.9	11.9	11.0	9.4	1.7	10.1
May	16.9	2.0	4.0	1.0	0.2	10.8	10.8	10.0	8.5	1.5	9.5
June	16.6	2.5	4.0	1.2	0.2	9.9	9.9	9.2	7.8	1.4	9.0
July	16.2	2.4	4.0	1.2	0.2	9.6	9.6	8.9	7.6	1.3	8.7
August	16.2	2.5	4.0	1.2	0.2	9.4	9.4	8.8	7.4	1.3	8.7
September	15.8	2.3	4.0	1.1	0.2	9.3	9.3	8.6	7.3	1.3	8.5
October	15.8	1.5	4.0	0.7	0.1	10.2	10.2	9.5	8.1	1.4	8.8
November	16.1	0.6	4.0	0.3	0.0	11.5	11.5	10.7	9.1	1.6	9.3
December	17.1	0.3	4.0	0.2	0.0	12.7	12.7	11.8	10.0	1.8	10.2
Avg (MGD)	***16.9***	***1.5***	***4.0***	***0.7***	***0.1***	***11.3***	***11.1***	***10.3***	***8.8***	***1.5***	***9.5***
				800	***AFY for NPR+***				***9,800***	***AFY for PR (88% utilization)***	***10,600 AFY***

2035 Flows, Lower Bound:

	Sunnyvale WPCP Flows (MGD)			Sunnyvale AWPF flows needed for NPR+ (MGD)			Sunnyvale Regional AWPF Flows (MGD) Purified water for potable reuse				
Month	**Future Influent**	**Future NPR Demand**	**Losses**	**Purified water needed for blending [a]**	**ROC from NPR+**	**Available Effluent (for PR) [b]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [c]**	**ROC**	**Total purified water produced**
January	12.8	0.6	4.0	0.3	0.1	8.2	8.2	7.6	6.4	1.1	6.7
February	12.9	0.7	4.0	0.4	0.1	8.1	8.1	7.6	6.4	1.1	6.8
March	13.0	1.1	4.0	0.5	0.1	7.8	7.8	7.3	6.2	1.1	6.7
April	12.3	1.5	4.0	0.7	0.1	6.6	6.6	6.2	5.3	0.9	6.0
May	11.9	2.0	4.0	1.0	0.2	5.8	5.8	5.4	4.5	0.8	5.5
June	11.7	2.5	4.0	1.2	0.2	5.0	5.0	4.6	3.9	0.7	5.1
July	11.3	2.4	4.0	1.2	0.2	4.8	4.8	4.4	3.8	0.7	4.9
August	11.3	2.5	4.0	1.2	0.2	4.6	4.6	4.3	3.6	0.6	4.9
September	11.1	2.3	4.0	1.1	0.2	4.6	4.6	4.2	3.6	0.6	4.7
October	11.1	1.5	4.0	0.7	0.1	5.5	5.5	5.1	4.3	0.8	5.1
November	11.3	0.6	4.0	0.3	0.0	6.7	6.7	6.2	5.3	0.9	5.6
December	12.0	0.3	4.0	0.2	0.0	7.6	7.6	7.1	6.0	1.1	6.2
Avg (MGD)	***11.9***	***1.5***	***4.0***	***0.7***	***0.1***	***6.3***	***6.3***	***5.8***	***4.9***	***0.9***	***5.6***
				800	***AFY for NPR+***				***5,500***	***AFY for PR***	***6,400 AFY***

Notes:
a) To achieve target TDS of 500 mg/L for NPR+
b) Available for PR or other purposes (e.g., discharge, blending); equals future influent - (future NPR demand + losses + ROC from NPR+)
c) Assumes MF recovery rate = 93%, RO recovery rate = 85%, and PR production capacity = 10 mgd (based on upper bound)
d) Drives overall production capacity (10.5 mgd)

Table B-3. Combined Palo Alto/Sunnyvale Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2035 Flows, Upper Bound:

	Palo Alto RWQCP and Sunnyvale WPCP (MGD)			Combined Regional AWPF Flows (MGD) Purified water for potable reuse			
Month	**PA Available Effluent (for PR)**	**SV Available Effluent (for PR)**	**Available Effluent - combined for PR [a]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [b]**	**ROC**
January	19.5	13.6	33.1	30.4	28.2	24.0	**4.2**
February	20.2	13.7	33.9	30.4	28.2	24.0	**4.2**
March	19.4	13.3	32.7	30.4	28.2	24.0	**4.2**
April	17.0	11.9	28.9	28.9	26.9	22.9	**4.0**
May	14.6	10.8	25.4	25.4	23.7	20.1	**3.6**
June	13.1	9.9	23.0	23.0	21.4	18.2	**3.2**
July	11.7	9.6	21.2	21.2	19.8	16.8	**3.0**
August	11.1	9.4	20.6	20.6	19.1	16.3	**2.9**
September	11.8	9.3	21.1	21.1	19.6	16.7	**2.9**
October	13.4	10.2	23.6	23.6	22.0	18.7	**3.3**
November	15.6	11.5	27.0	27.0	25.1	21.4	**3.8**
December	17.0	12.7	29.7	29.7	27.7	23.5	**4.1**
Avg (MGD)	***15.3***	***11.3***	***26.7***	***26.0***	***24.2***	***20.5***	***3.6***

23,000 ***AFY for PR***
(85% utilization)

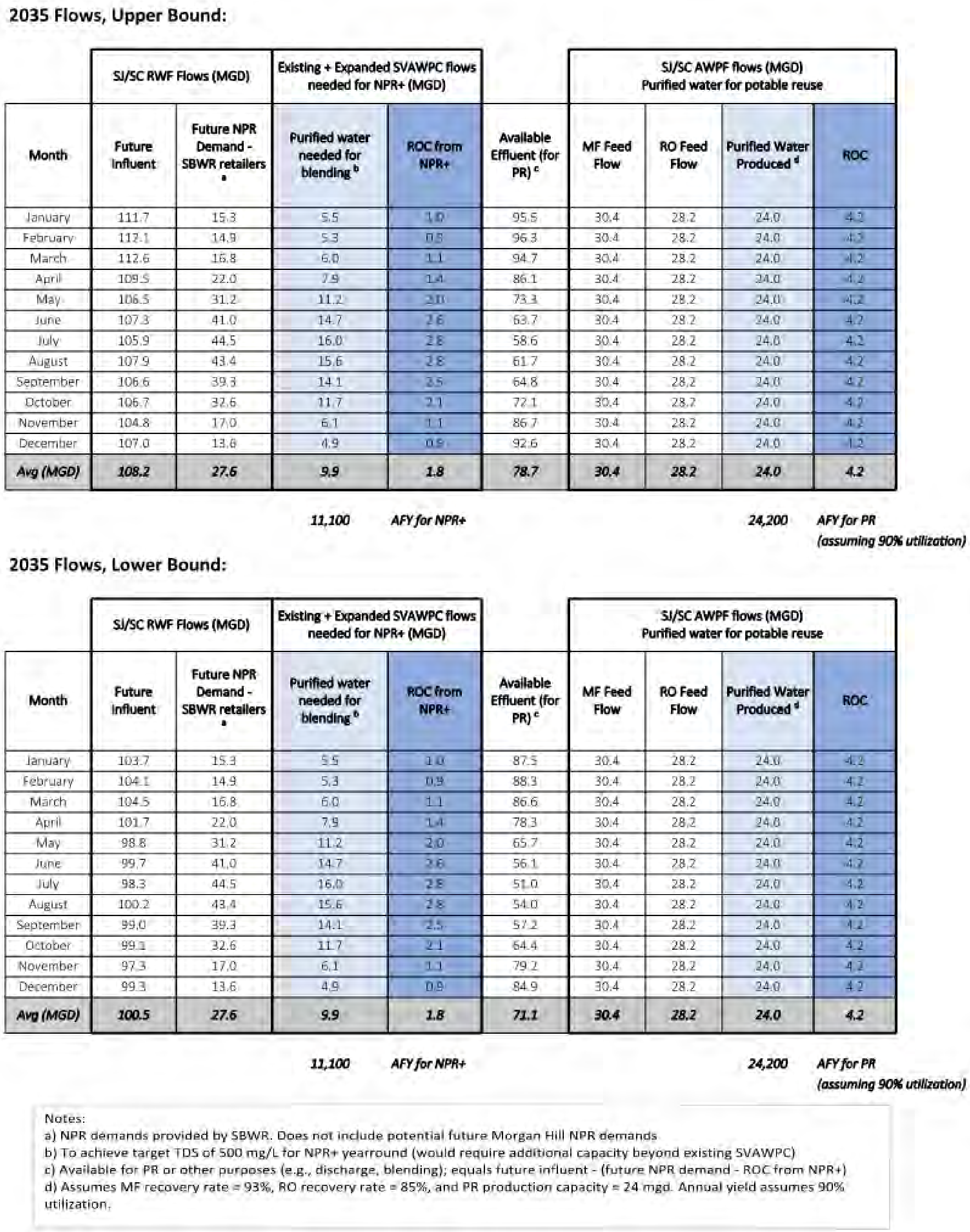
2035 Flows, Lower Bound:

	Palo Alto RWQCP and Sunnyvale WPCP (MGD)			Combined Regional AWPF Flows (MGD) Purified water for potable reuse			
Month	**PA Available Effluent (for PR)**	**SV Available Effluent (for PR)**	**Available Effluent - combined for PR [a]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [b]**	**ROC**
January	17.2	8.2	25.4	25.4	23.6	20.1	**3.5**
February	17.9	8.1	26.0	26.0	24.2	20.6	**3.6**
March	17.1	7.8	24.9	24.9	23.1	19.7	**3.5**
April	14.8	6.6	21.5	21.5	20.0	17.0	**3.0**
May	12.5	5.8	18.3	18.3	17.0	14.5	**2.6**
June	11.0	5.0	16.0	16.0	14.9	12.6	**2.2**
July	9.7	4.8	14.5	14.5	13.5	11.5	**2.0**
August	9.2	4.6	13.8	13.8	12.9	10.9	**1.9**
September	9.9	4.6	14.5	14.5	13.5	11.5	**2.0**
October	11.5	5.5	17.0	17.0	15.8	13.4	**2.4**
November	13.6	6.7	20.3	20.3	18.9	16.1	**2.8**
December	15.0	7.6	22.6	22.6	21.0	17.9	**3.2**
Avg (MGD)	***13.3***	***6.3***	***19.5***	***19.5***	***18.2***	***15.4***	***2.7***

17,300 ***AFY for PR***

Notes:
a) Available for PR or other purposes (e.g., discharge, blending); equals future influent - (future NPR demand + losses + ROC from NPR+)
b) Assumes MF recovery rate = 93%, RO recovery rate = 85%, and PR production capacity = 24 mgd (based on upper bound). Additional 0.5 mgd capacity needed for NPR+ in Sunnyvale

Table B-4. San Jose/Santa Clara Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2035 Flows, Upper Bound:

	SJ/SC RWF Flows (MGD)		Existing + Expanded SVAWPC flows needed for NPR+ (MGD)			SJ/SC AWPF flows (MGD) Purified water for potable reuse			
Month	Future Influent	Future NPR Demand - SBWR retailers [a]	Purified water needed for blending [b]	ROC from NPR+	Available Effluent (for PR) [c]	MF Feed Flow	RO Feed Flow	Purified Water Produced [d]	ROC
January	111.7	15.3	5.5	1.0	95.5	30.4	28.2	24.0	4.2
February	112.1	14.9	5.3	0.9	96.3	30.4	28.2	24.0	4.2
March	112.6	16.8	6.0	1.1	94.7	30.4	28.2	24.0	4.2
April	109.5	22.0	7.9	1.4	86.1	30.4	28.2	24.0	4.2
May	106.5	31.2	11.2	2.0	73.3	30.4	28.2	24.0	4.2
June	107.3	41.0	14.7	2.6	63.7	30.4	28.2	24.0	4.2
July	105.9	44.5	16.0	2.8	58.6	30.4	28.2	24.0	4.2
August	107.9	43.4	15.6	2.8	61.7	30.4	28.2	24.0	4.2
September	106.6	39.3	14.1	2.5	64.8	30.4	28.2	24.0	4.2
October	106.7	32.6	11.7	2.1	72.1	30.4	28.2	24.0	4.2
November	104.8	17.0	6.1	1.1	86.7	30.4	28.2	24.0	4.2
December	107.0	13.6	4.9	0.9	92.6	30.4	28.2	24.0	4.2
Avg (MGD)	***108.2***	***27.6***	***9.9***	***1.8***	***78.7***	***30.4***	***28.2***	***24.0***	***4.2***

11,100 ***AFY for NPR+***

24,200 ***AFY for PR***
(assuming 90% utilization)

2035 Flows, Lower Bound:

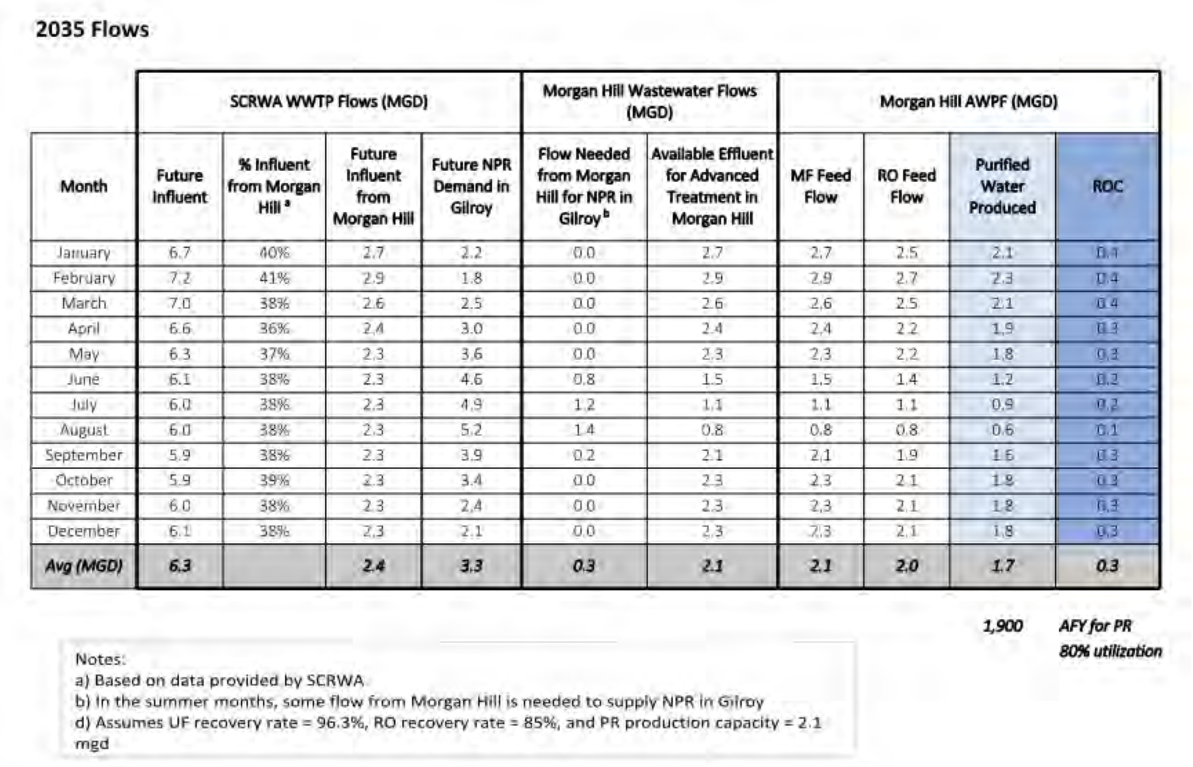
	SJ/SC RWF Flows (MGD)		Existing + Expanded SVAWPC flows needed for NPR+ (MGD)			SJ/SC AWPF flows (MGD) Purified water for potable reuse			
Month	Future Influent	Future NPR Demand - SBWR retailers [a]	Purified water needed for blending [b]	ROC from NPR+	Available Effluent (for PR) [c]	MF Feed Flow	RO Feed Flow	Purified Water Produced [d]	ROC
January	103.7	15.3	5.5	1.0	87.5	30.4	28.2	24.0	4.2
February	104.1	14.9	5.3	0.9	88.3	30.4	28.2	24.0	4.2
March	104.5	16.8	6.0	1.1	86.6	30.4	28.2	24.0	4.2
April	101.7	22.0	7.9	1.4	78.3	30.4	28.2	24.0	4.2
May	98.8	31.2	11.2	2.0	65.7	30.4	28.2	24.0	4.2
June	99.7	41.0	14.7	2.6	56.1	30.4	28.2	24.0	4.2
July	98.3	44.5	16.0	2.8	51.0	30.4	28.2	24.0	4.2
August	100.2	43.4	15.6	2.8	54.0	30.4	28.2	24.0	4.2
September	99.0	39.3	14.1	2.5	57.2	30.4	28.2	24.0	4.2
October	99.1	32.6	11.7	2.1	64.4	30.4	28.2	24.0	4.2
November	97.3	17.0	6.1	1.1	79.2	30.4	28.2	24.0	4.2
December	99.3	13.6	4.9	0.9	84.9	30.4	28.2	24.0	4.2
Avg (MGD)	***100.5***	***27.6***	***9.9***	***1.8***	***71.1***	***30.4***	***28.2***	***24.0***	***4.2***

11,100 ***AFY for NPR+***

24,200 ***AFY for PR***
(assuming 90% utilization)

Notes:
a) NPR demands provided by SBWR. Does not include potential future Morgan Hill NPR demands
b) To achieve target TDS of 500 mg/L for NPR+ yearround (would require additional capacity beyond existing SVAWPC)
c) Available for PR or other purposes (e.g., discharge, blending); equals future influent - (future NPR demand - ROC from NPR+)
d) Assumes MF recovery rate = 93%, RO recovery rate = 85%, and PR production capacity = 24 mgd. Annual yield assumes 90% utilization.

Table B-5. Morgan Hill Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2035 Flows

	SCRWA WWTP Flows (MGD)				Morgan Hill Wastewater Flows (MGD)		Morgan Hill AWPF (MGD)			
Month	Future Influent	% Influent from Morgan Hill [a]	Future Influent from Morgan Hill	Future NPR Demand in Gilroy	Flow Needed from Morgan Hill for NPR in Gilroy [b]	Available Effluent for Advanced Treatment in Morgan Hill	MF Feed Flow	RO Feed Flow	Purified Water Produced	ROC
January	6.7	40%	2.7	2.2	0.0	2.7	2.7	2.5	2.1	0.4
February	7.2	41%	2.9	1.8	0.0	2.9	2.9	2.7	2.3	0.4
March	7.0	38%	2.6	2.5	0.0	2.6	2.6	2.5	2.1	0.4
April	6.6	36%	2.4	3.0	0.0	2.4	2.4	2.2	1.9	0.3
May	6.3	37%	2.3	3.6	0.0	2.3	2.3	2.2	1.8	0.3
June	6.1	38%	2.3	4.6	0.8	1.5	1.5	1.4	1.2	0.2
July	6.0	38%	2.3	4.9	1.2	1.1	1.1	1.1	0.9	0.2
August	6.0	38%	2.3	5.2	1.4	0.8	0.8	0.8	0.6	0.1
September	5.9	38%	2.3	3.9	0.2	2.1	2.1	1.9	1.6	0.3
October	5.9	39%	2.3	3.4	0.0	2.3	2.3	2.1	1.8	0.3
November	6.0	38%	2.3	2.4	0.0	2.3	2.3	2.1	1.8	0.3
December	6.1	38%	2.3	2.1	0.0	2.3	7.3	2.1	1.8	0.3
Avg (MGD)	***6.3***		***2.4***	***3.3***	***0.3***	***2.1***	***2.1***	***2.0***	***1.7***	***0.3***

1,900 ***AFY for PR***

80% utilization

Notes:
a) Based on data provided by SCRWA
b) In the summer months, some flow from Morgan Hill is needed to supply NPR in Gilroy
d) Assumes UF recovery rate = 96.3%, RO recovery rate = 85%, and PR production capacity = 2.1 mgd

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Attachment C: AWPF Sizing Calculations

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Table C-1. Determination of Portfolio 1 AWPF Capacity and Utilization, SJ/SC AWPF

2035 Flow (upper bound)

LEGEND

🟩	Recommended capacity (to achieve 24,000 AFY @ 90% utilization)
🟧	Capacity that would maximize potable reuse

Notes:
1. Values shown below represent purified water for potable reuse (NPR+ considered separately).
2. SJ/SC RWF has enough effluent to produce more purified water. Assume 90% utilization for sizing purposes and select capacity based on meeting 24,000 AFY PR goal

Purified Water Production Capacity (for PR) =				**20.0**		**21.0**		**22.0**		**23.0**		**24.0**		**40.0**		**60.0**		**76.1**		**80.0**		**100.0**	
Alt 1. 2035		**Available Effluent for PR - San Jose (mgd)**	**Total Available Effluent for PR (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**	**MF feed flow (mgd)**	**Purified water produced (mgd)**
January		95.5	95.5	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	95.5	75.5	95.5	75.5	95.5	75.5
February		96.3	96.3	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	96.3	76.1	96.3	76.1	96.3	76.1
March		94.7	94.7	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	94.7	74.9	94.7	74.9	94.7	74.9
April		86.1	86.1	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	86.1	68.1	86.1	68.1	86.1	68.1
May		73.3	73.3	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	73.3	58.0	73.3	58.0	73.3	58.0	73.3	58.0
June		63.7	63.7	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	63.7	50.4	63.7	50.4	63.7	50.4	63.7	50.4
July		58.6	58.6	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	58.6	46.3	58.6	46.3	58.6	46.3	58.6	46.3
August		61.7	61.7	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	61.7	48.8	61.7	48.8	61.7	48.8	61.7	48.8
September		64.8	64.8	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	64.8	51.2	64.8	51.2	64.8	51.2	64.8	51.2
October		72.1	72.1	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	72.1	57.0	72.1	57.0	72.1	57.0	72.1	57.0
November		86.7	86.7	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	86.7	68.6	86.7	68.6	86.7	68.6
December		92.6	92.6	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	92.6	73.2	92.6	73.2	92.6	73.2
			Average Annual (mgd):		20.0		21.0		22.0		23.0		24.0		40.0		55.9		62.2		62.2		62.2
			Actual production (AFY):		22,396		23,516		24,636		25,756		26,876		44,793		62,653		69,710		69,710		69,710
			Utilization %:		100%		100%		100%		100%		100%		100%		93%		82%		78%		62%
			Incrementatal utilization %:				100%		100%		100%		100%		100%		80%		39%		0%		0%
			Production @90% utilization (AFY):		**20,157**		**21,165**		**22,172**		**23,180**		**24,188**		**40,314**		**56,388**		**62,739**		**62,739**		**62,739**

Table C-2. Determination of Portfolio 2 AWPF Capacity and Utilization, Combined Regional Palo Alto/Sunnyvale AWPF

Porfolio 2 - Combined Regional AWPF

2035 Flow (upper bound)

LEGEND

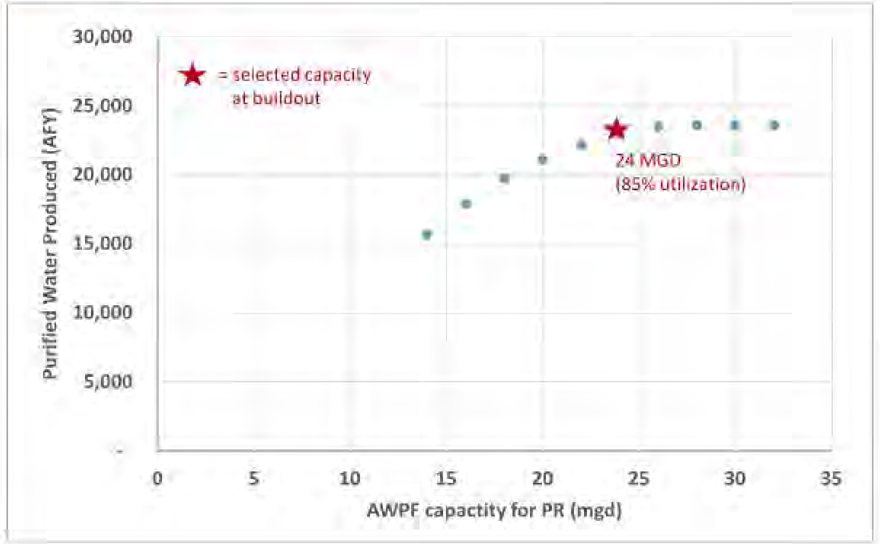
🟩 Recommended capacity

🟧 Capacity that would maximize potable reuse

Notes:

1. Combined regional AWPF receives feed flow from both Palo Alto and Sunnyvale (though could be located in either city).
2. Values shown below represent purified water for potable reuse (additional capacity would be needed for NPR+ in Sunnyvale).

			Production Capacity (for PR) =	16.0		18.0		20.0		22.0		🟩 24.0		26.0		🟧 26.8		28.0	
Portfolio 2 2035	Available Effluent for PR - Palo Alto (mgd)	Available Effluent for PR - Sunnyvale (mgd)	Total Available Effluent for PR (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	19.5	13.6	33.1	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	30.4	24.0	32.9	26.0	33.1	26.2	33.1	26.2
February	20.2	13.7	33.9	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	30.4	24.0	32.9	26.0	33.9	26.8	33.9	26.8
March	19.4	13.3	32.7	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	30.4	24.0	32.7	25.9	32.7	25.9	32.7	25.9
April	17.0	11.9	28.9	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	28.9	22.9	28.9	22.9	28.9	22.9	28.9	22.9
May	14.6	10.8	25.4	20.2	16.0	22.8	18.0	25.3	20.0	25.4	20.1	25.4	20.1	25.4	20.1	25.4	20.1	25.4	20.1
June	13.1	9.9	23.0	20.2	16.0	22.8	18.0	23.0	18.2	23.0	18.2	23.0	18.2	23.0	18.2	23.0	18.2	23.0	18.2
July	11.7	9.6	21.2	20.2	16.0	21.2	16.8	21.2	16.8	21.2	16.8	21.2	16.8	21.2	16.8	21.2	16.8	21.2	16.8
August	11.1	9.4	20.6	20.2	16.0	20.6	16.3	20.6	16.3	20.6	16.3	20.6	16.3	20.6	16.3	20.6	16.3	20.6	16.3
September	11.8	9.3	21.1	20.2	16.0	21.1	16.7	21.1	16.7	21.1	16.7	21.1	16.7	21.1	16.7	21.1	16.7	21.1	16.7
October	13.4	10.2	23.6	20.2	16.0	22.8	18.0	23.6	18.7	23.6	18.7	23.6	18.7	23.6	18.7	23.6	18.7	23.6	18.7
November	15.6	11.5	27.0	20.2	16.0	22.8	18.0	25.3	20.0	27.0	21.4	27.0	21.4	27.0	21.4	27.0	21.4	27.0	21.4
December	17.0	12.7	29.7	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	29.7	23.5	29.7	23.5	29.7	23.5	29.7	23.5
			Average annual (mgd):		16.0		17.6		18.9		19.8		20.5		21.0		21.1		21.1
			Actual production (AFY):		17,917		19,752		21,134		22,197		🟩 22,972		23,513		🟧 23,597		23,597
			Utilization %:		100%		98%		94%		90%		85%		81%		79%		75%
			Incrementatal utilization %:		100%		82%		62%		47%		35%		24%		9%		0%



2035 Flow (lower bound)

			Production Capacity (for PR) =	16.0		🟩 18.0		20.0		🟧 20.6		22.0		24.0		26.0		28.0	
Portfolio 2 2035	Available Effluent for PR - Palo Alto (mgd)	Available Effluent for PR - Sunnyvale (mgd)	Total Available Effluent for PR (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	17.2	8.2	25.4	20.2	16.0	22.8	18.0	25.3	20.0	25.4	20.1	25.4	20.1	25.4	20.1	25.4	20.1	25.4	20.1
February	17.9	8.1	26.0	20.2	16.0	22.8	18.0	25.3	20.0	26.0	20.6	26.0	20.6	26.0	20.6	26.0	20.6	26.0	20.6
March	17.1	7.8	24.9	20.2	16.0	22.8	18.0	24.9	19.7	24.9	19.7	24.9	19.7	24.9	19.7	24.9	19.7	24.9	19.7
April	14.8	6.6	21.5	20.2	16.0	21.5	17.0	21.5	17.0	21.5	17.0	21.5	17.0	21.5	17.0	21.5	17.0	21.5	17.0
May	12.5	5.8	18.3	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5
June	11.0	5.0	16.0	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6
July	9.7	4.8	14.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5
August	9.2	4.6	13.8	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9
September	9.9	4.6	14.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5
October	11.5	5.5	17.0	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4
November	13.6	6.7	20.3	20.2	16.0	20.3	16.1	20.3	16.1	20.3	16.1	20.3	16.1	20.3	16.1	20.3	16.1	20.3	16.1
December	15.0	7.6	22.6	20.2	16.0	22.6	17.9	22.6	17.9	22.6	17.9	22.6	17.9	22.6	17.9	22.6	17.9	22.6	17.9
			Average annual (mgd):		14.2		14.9		15.4		15.4		15.4		15.4		15.4		15.4
			Actual production (AFY):		15,886		🟩 16,712		17,234		🟧 17,291		17,291		17,291		17,291		17,291
			Utilization %:		89%		83%		77%		75%		70%		64%		59%		55%
			Incrementatal utilization %:		52%		37%		23%		8%		0%		0%		0%		0%

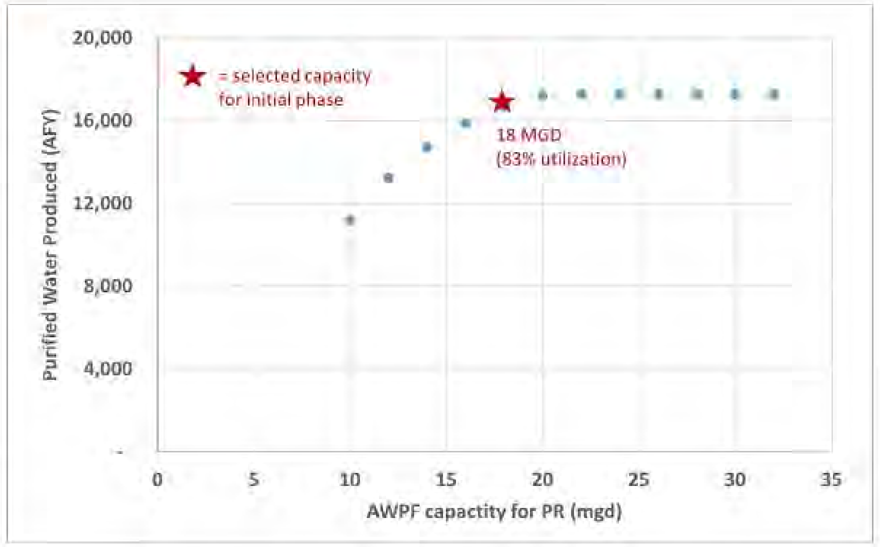


Table C-3. Determination of Portfolio 4 AWPF Capacity and Utilization, Separate Regional AWPF in Palo Alto

Porfolio 4 - Separate Regional AWPF in Palo Alto

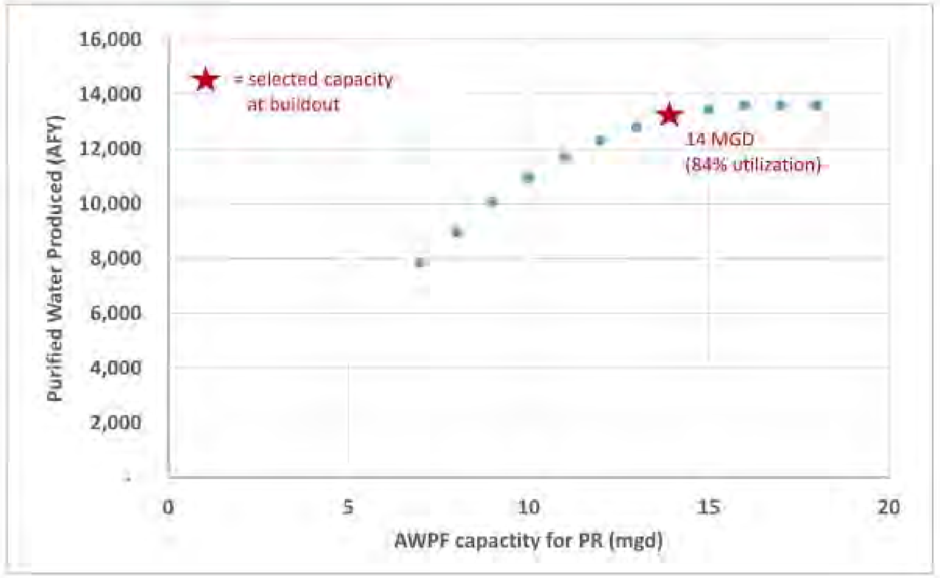
2035 Flow (upper bound)

LEGEND

🟩 Recommended capacity
🟧 Capacity that would maximize potable

Notes:
1. Regional AWPF receives feed flow from Palo Alto (a separate regional facility is located in Sunnyvale).
2. Values shown below represent purified water for potable reuse. Assumes a separate AWPF for NPR+ in Palo Alto.

Production Capacity (for PR) =		10.0		11.0		12.0		13.0		14.0		15.0		16.0		17.0	
Portfolio 4 2035	Available effluent for PR - Palo Alto (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	19.5	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.7	14.0	19.0	15.0	19.5	15.4	19.5	15.4
February	20.2	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.7	14.0	19.0	15.0	20.2	16.0	20.2	16.0
March	19.4	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.7	14.0	19.0	15.0	19.4	15.3	19.4	15.3
April	17.0	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.0	13.5	17.0	13.5	17.0	13.5	17.0	13.5
May	14.6	12.7	10.0	13.9	11.0	14.6	11.6	14.6	11.6	14.6	11.6	14.6	11.6	14.6	11.6	14.6	11.6
June	13.1	12.7	10.0	13.1	10.3	13.1	10.3	13.1	10.3	13.1	10.3	13.1	10.3	13.1	10.3	13.1	10.3
July	11.7	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2
August	11.1	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8
September	11.8	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3
October	13.4	12.7	10.0	13.4	10.6	13.4	10.6	13.4	10.6	13.4	10.6	13.4	10.6	13.4	10.6	13.4	10.6
November	15.6	12.7	10.0	13.9	11.0	15.2	12.0	15.6	12.3	15.6	12.3	15.6	12.3	15.6	12.3	15.6	12.3
December	17.0	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4
Average annual (mgd):			9.8		10.4		11.0		11.4		11.7		12.0		12.1		12.1
Actual production (AFY):			10,949		11,688		12,299		12,789		13,150		13,426		13,582		13,582
Utilization %:			98%		95%		92%		88%		84%		80%		76%		71%
Incrementatal utilization %:			79%		66%		54%		44%		32%		25%		14%		0%



2035 Flow (lower bound)

Production Capacity (for PR) =		10.0		11.0		12.0		13.0		14.1		15.0		16.0		17.0	
Portfolio 4 2035	Available effluent for PR - Palo Alto (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	17.2	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.2	13.6	17.2	13.6	17.2	13.6	17.2	13.6
February	17.9	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.8	14.1	17.9	14.1	17.9	14.1	17.9	14.1
March	17.1	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.1	13.5	17.1	13.5	17.1	13.5	17.1	13.5
April	14.8	12.7	10.0	13.9	11.0	14.8	11.7	14.8	11.7	14.8	11.7	14.8	11.7	14.8	11.7	14.8	11.7
May	12.5	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9
June	11.0	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7
July	9.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7
August	9.2	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3
September	9.9	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8
October	11.5	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1
November	13.6	12.7	10.0	13.6	10.8	13.6	10.8	13.6	10.8	13.6	10.8	13.6	10.8	13.6	10.8	13.6	10.8
December	15.0	12.7	10.0	13.9	11.0	15.0	11.8	15.0	11.8	15.0	11.8	15.0	11.8	15.0	11.8	15.0	11.8
Average annual (mgd):			9.2		9.7		10.1		10.3		10.5		10.5		10.5		10.5
Actual production (AFY):			10,313		10,847		11,269		11,546		11,746		11,750		11,750		11,750
Utilization %:			92%		88%		84%		79%		74%		70%		66%		62%
Incrementatal utilization %:			58%		48%		38%		25%		16%		0%		0%		0%

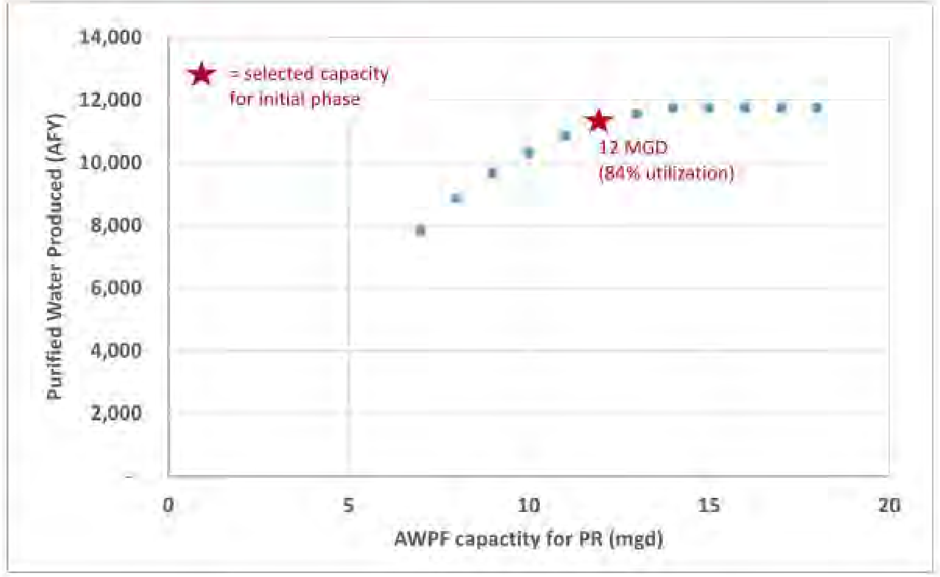


Table C-4. Determination of Portfolio 4 AWPF Capacity and Utilization, Separate Regional AWPF in Sunnyvale

Porfolio 4 - Separate Regional AWPF in Sunnyvale

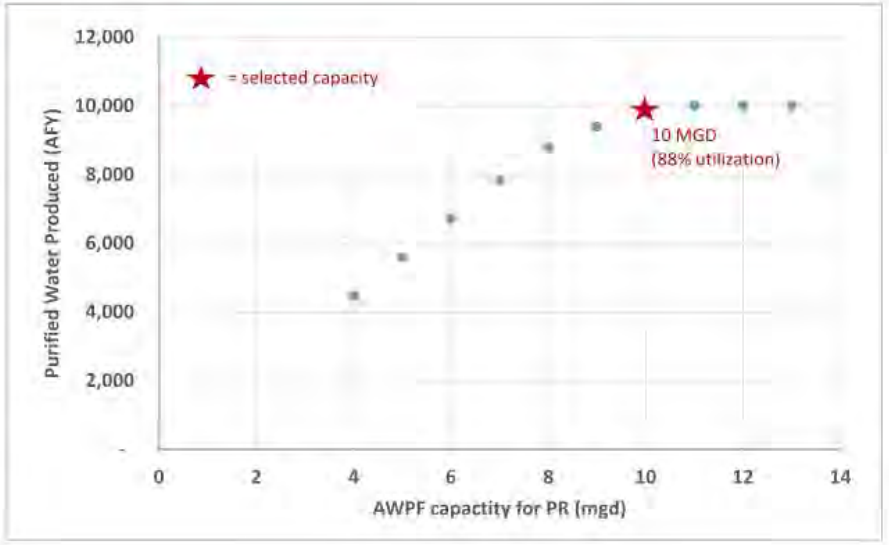
2035 Flow (upper bound)

LEGEND

🟩 Recommended capacity
🟧 Capacity that would maximize potable reus

Notes:
1. Regional AWPF receives feed flow from Sunnyvale (a separate regional facility is located in Palo Alto).
2. Values shown below represent purified water for potable reuse (additional capacity would be needed for NPR+ in Sunnyvale).

Production Capacity (for PR) =		5.0		6.0		7.0		8.0		9.0		10.0		10.8		12.0	
Portfolio 4 2035	Available Effluent for PR - Sunnyvale (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)
January	13.6	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	12.7	10.0	13.6	10.8	13.6	10.8
February	13.7	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	12.7	10.0	13.7	10.8	13.7	10.8
March	13.3	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	12.7	10.0	13.3	10.6	13.3	10.6
April	11.9	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	11.9	9.4	11.9	9.4	11.9	9.4
May	10.8	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	10.8	8.5	10.8	8.5	10.8	8.5	10.8	8.5
June	9.9	6.3	5.0	7.6	6.0	8.9	7.0	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8
July	9.6	6.3	5.0	7.6	6.0	8.9	7.0	9.6	7.6	9.6	7.6	9.6	7.6	9.6	7.6	9.6	7.6
August	9.4	6.3	5.0	7.6	6.0	8.9	7.0	9.4	7.4	9.4	7.4	9.4	7.4	9.4	7.4	9.4	7.4
September	9.3	6.3	5.0	7.6	6.0	8.9	7.0	9.3	7.3	9.3	7.3	9.3	7.3	9.3	7.3	9.3	7.3
October	10.2	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	10.2	8.1	10.2	8.1	10.2	8.1	10.2	8.1
November	11.5	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	11.5	9.1	11.5	9.1	11.5	9.1
December	12.7	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	12.7	10.0	12.7	10.1	12.7	10.1
Average annual (mgd):			5.0		6.0		7.0		7.8		8.4		8.8		8.9		8.9
Actual production (AFY):			5,599		6,719		7,839		8,788		9,402		9,815		10,015		10,015
Utilization %:			100%		100%		100%		98%		93%		88%		83%		75%
Incrementatal utilization %:			100%		100%		100%		85%		55%		37%		22%		0%



2035 Flow (lower bound)

Production Capacity (for PR) =		5.0		6.0		6.4		8.0		9.0		10.0		11.0		12.0	
Portfolio 4 2035	Available Effluent for PR - Sunnyvale (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)
January	8.2	6.3	5.0	7.6	6.0	8.1	6.4	8.2	6.4	8.2	6.4	8.2	6.4	8.2	6.4	8.2	6.4
February	8.1	6.3	5.0	7.6	6.0	8.1	6.4	8.1	6.4	8.1	6.4	8.1	6.4	8.1	6.4	8.1	6.4
March	7.8	6.3	5.0	7.6	6.0	7.8	6.2	7.8	6.2	7.8	6.2	7.8	6.2	7.8	6.2	7.8	6.2
April	6.6	6.3	5.0	6.6	5.3	6.6	5.3	6.6	5.3	6.6	5.3	6.6	5.3	6.6	5.3	6.6	5.3
May	5.8	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5
June	5.0	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9
July	4.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8
August	4.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6
September	4.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6
October	5.5	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3
November	6.7	6.3	5.0	6.7	5.3	6.7	5.3	6.7	5.3	6.7	5.3	6.7	5.3	6.7	5.3	6.7	5.3
December	7.6	6.3	5.0	7.6	6.0	7.6	6.0	7.6	6.0	7.6	6.0	7.6	6.0	7.6	6.0	7.6	6.0
Average annual (mgd):			4.5		4.9		4.9		4.9		4.9		4.9		4.9		4.9
Actual production (AFY):			5,018		5,438		5,540		5,540		5,540		5,540		5,540		5,540
Utilization %:			90%		81%		77%		62%		55%		49%		45%		41%
Incrementatal utilization %:			57%		38%		21%		0%		0%		0%		0%		0%

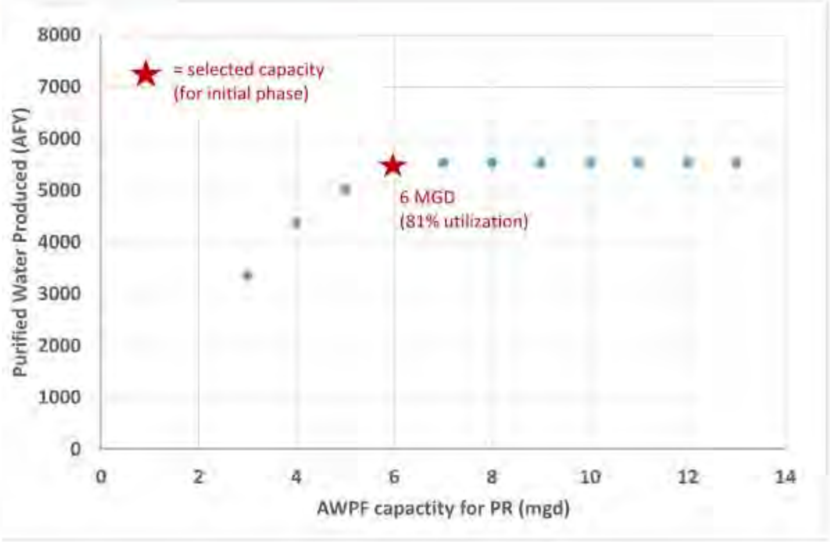


Table C-5. Determination of Morgan Hill AWPF Capacity and Utilization

2035 Flow (upper bound)

LEGEND

🟩 Recommended capacity

🟧 Capacity that would maximize potable reuse

Notes:

1. Available effluent based on Morgan Hill's contribution to SCRWA WWTP, minus flow needed to meet NPR demands in Gilroy.

		1.50		1.60		1.70		1.8		1.9		2.0		2.1		2.2		2.3		2.4		2.5	
2035	Available Effluent for PR - Morgan Hill (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	2.7	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.4	2.0	2.6	2.1	2.7	2.2	2.7	2.2	2.7	2.2	2.7	2.2
February	2.9	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.4	2.0	2.6	2.1	2.7	2.2	2.8	2.3	2.9	2.4	2.9	2.4
March	2.6	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.4	2.0	2.6	2.1	2.6	2.2	2.6	2.2	2.6	2.2	2.6	2.2
April	2.4	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.4	2.0	2.4	2.0	2.4	2.0	2.4	2.0	2.4	2.0	2.4	2.0
May	2.3	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9
June	1.5	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2
July	1.1	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9
August	0.8	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7
September	2.1	1.8	1.5	2.0	1.6	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7
October	2.3	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9
November	2.3	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9
December	2.3	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9
Average Annual (mgd):			1.4		1.4		1.5		1.6		1.6		1.7		1.7		1.7		1.7		1.7		1.7
Actual production (AFY):			1519		1603		1687		1762		1830		1865		1893		1917		1926		1933		1933
Utilization %:			90%		89%		89%		87%		86%		83%		80%		78%		75%		72%		69%
Incrementatal utilization %:					75%		75%		67%		61%		31%		25%		21%		8%		7%		0%

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Appendix A-3: Design Criteria

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Appendix A-3

Design Criteria

A.1 North County Advanced Water Purification Facilities (AWPF)

A.1.1 Portfolios Evaluated

Table A-1 summarizes the portfolios evaluated as part of the Countywide Water Reuse preliminary level design of AWPFs.

Table A-1. North County AWPFs by Portfolio

Portfolio number	Description	Source flow	AWPF location	Design capacity and treatment process
1a	Ground Water Reuse (GWR) in Los Gatos Recharge Ponds	San José/Santa Clara (SJ/SC) Regional Wastewater Facility (RWF)	San José	24 million gallons per day (mgd) plant with full advanced treatment (FAT) process
1b	Raw Water Augmentation (RWA) at Penitencia Water Treatment Plant (WTP)	SJ/SC RWF	San José	24-mgd plant with FAT process plus ozone-biological activated carbon (O_3-BAC)
1c	Treated Water Augmentation (TWA) with direct delivery to Santa Clara, San José, San Jose Water, and Valley Water	SJ/SC RWF	San José	24-mgd plant with FAT process plus O_3-BAC and chlorine disinfection
1d	TWA with direct delivery to Santa Clara, San José, San Jose Water	SJ/SC RWF	San José	24-mgd plant with FAT process plus O_3-BACand chlorine disinfection
2a	Combined Regional AWPF located in Palo Alto delivering water to Los Gatos Recharge Ponds for GWR.	Palo Alto Regional Water Quality Control Plant (RWQCP) and Sunnyvale Water Pollution Control Plant (WPCP)	Palo Alto	24.5-mgd plant with FAT process, including equalization basin
2b	Combined Regional AWPF located in Sunnyvale delivering water to Los Gatos Recharge Ponds for GWR.	Palo Alto RWQCP and Sunnyvale WPCP	Sunnyvale	24.5-mgd plant with FAT process, including equalization basin
4a	Separate Regional AWPFs in Palo Alto and Sunnyvale delivering water to Los Gatos Recharge Ponds for GWR.	Palo Alto RWQCP	Palo Alto	14-mgd plant with FAT process, including equalization basin
4b		Sunnyvale WPCP	Sunnyvale	10.5-mgd plant with FAT process, including equalization basin
Westside TWA	Combined Regional AWPF located in Palo Alto delivering TWA water to the West Pipeline at Stevens Creek.	Palo Alto RWQCP and Sunnyvale WPCP	Palo Alto	24.5-mgd plant with FAT process plus ozone-BAC and chlorine disinfection, including equalization basin

Notes:

Assume FAT system includes ultrafiltration (UF) system > reverse osmosis (RO) system > decarbonator system > ultraviolet/advanced oxidation process (UV/AOP) > purified water

A.1.2 Water Quality

Estimated feed water quality presented in Table A-2 is based on *Expedited Purified Water Program Direct Potable Reuse Facilities Plan.* The data were assembled from historical SJ/SC RWF data collected monthly (March 2011 to March 2016) and supplemented with quarterly and grab sample data. These data were assumed as a basis for designing each North County AWPF. Variations in actual water quality from other North County treatment facilities could result in different capital or operations and maintenance (O&M) costs but are not considered at this level of analysis.

Table A-2. Estimate Feed Water Quality

Parameter	Units	Historical data				Design value
		Min	Max	90th Percentile	Average	
1, 4-dioxane	µg/L	--	--	--	--	4.4
Alkalinity, total	mg/L as $CaCO_3$	--	--	--	--	152
Ammonia, total	mg/L as N	0.16	3.2	1.3	0.75	1.3
Calcium	mg/L	--	--	--	--	44
Chloride	mg/L	--	--	--	--	267
Chlorine, total residual	mg/L	--	--	--	--	0.5
Conductivity	µS/cm	--	--	--	--	1,600
Magnesium	mg/L	--	--	--	--	26
NDMA	ng/L	--	--	--	--	100
Nitrate + nitrite (calculated)	mg/L as N	12	23	20	17	20
Nitrogen, total (as N)	mg/L	13	24	21	18	21
pH	unit	6.9	8.1	7.6	7.4	7.6
Phosphate	mg/L as PO_4	--	--	--	--	6.7
Silica	mg/L as SiO_2	--	--	--	--	24
Sodium	mg/L	--	--	--	--	200
Sulfate	mg/L	--	--	--	--	86
Total dissolved solids (TDS)	mg/L	650	990	851	770	851
Temperature	°C	14	26	24	21	14
Total organic carbon (TOC)	mg/L	7	43	9	9	10
Total Kjeldahl Nitrogen (TKN) (as N)	mg/L	1.1	3.9	2.0	1.6	2.0
Turbidity	NTU	0.0	4.0	1.70	1.2	1.7

Notes: Source: Valley Water, "Expedited Purified Water Program Plan, Appendix C – Direct Potable Reuse Facilities Plan." February 2018.

µg/L = micrograms per liter

µS/cm = microsiemens per centimeter

$CaCO_3$ = calcium carbonate

mg/L = milligrams per liter

ng/L – nanogram per liter

NDMA = N-nitrosodimethylamine

NTU = Nephelometric turbidity unit

A.1.3 Influent Pump Station/Equalization Basin

Wastewater effluent from the sources identified in Table A-1 would be conveyed to each of the respective AWPFs being considered. For Palo Alto and Sunnyvale AWPFs, wastewater effluent would be conveyed into equalization basins upstream of treatment. The influent pumps described in Table A-3 would convey water through the influent strainers and UF filter modules. A disinfection residual (chloramines) is assumed to be provided at the influent pump station/ equalization basin, upstream of the UF system to minimize biofouling of the UF and RO membranes. Chemicals used and dosing amounts are noted in Table A-3.

Table A-3. Influent Pump Station Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Feed flow	mgd	30.7	30.7	30.7	31.3	31.3	17.9	13.4
Wetwell/equalization basin volume	MG	0.5	0.5	0.5	3.0	3.0	2.5	2.0
Number of pumps	--	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby
Type	--	Vertical diffusion vane pump[a]	Vertical diffusion vane pump[a]	Vertical diffusion vane pump[a]	Vertical turbine pump	Vertical turbine pump	Vertical turbine pump	Vertical turbine pump
Capacity, each	gpm	7,600	7,600	7,600	5,400	5,400	3,200	2,400
Total dynamic head (TDH), each	ft	±133	±133	±133	±105	±105	±106	±106
Motor size	hp	500	500	500	200	200	125	100
Pump efficiency	%	±80%	±80%	±80%	±80%	±80%	±80%	±80%
Variable-frequency Drive (VFD)	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hypochlorite dose for chloramine residual	mg/L	1.5[b,c]	1.5[b,c]	1.5[b,c]	1.5[b,c]	1.5[b,c]	1.5[b,c]	1.5[b,c]
Aqueous ammonia dose for chloramine residual	mg/L	0.5[c]	0.5[c]	0.5[c]	0.5[c]	0.5[c]	0.5[c]	0.5[c]

Influent pump station design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 2a.

a. Match existing pumps at SVAWPC.

b. Estimated dose for 2 mg/L chloramine residual.

c. Assumes 0.5 mg/L residual from disinfected tertiary effluent.

MG = million gallons

SVAWPC = Silicon Valley Advanced Water Purification Center

A.1.4 Ozone and Biologically Activated Carbon

Based on the *Expedited Purified Water Program Plan* RWA AWPF concept, O_3-BAC pretreatment is recommended for the RWA and TWA treatment train to gain log removal value (LRV) credit and improve downstream processes, including disinfection, total organic carbon (TOC) reduction, and membrane performance. Details for the O_3-BAC system are presented in Table A-4 and based on information provided by WEDECO, Inc.

Table A-4. Ozone and BAC Design Criteria for Portfolio 1b			
		SJ/SC RWF	
Parameter	Units	1b (RWA)	1c and 1d (TWA)
Ozone System			
Ozone range:TOC (ratio)	N/A (ratio)	0.6-1.3:1	0.6-1.3:1
Ozone dose	mg/L	6	6
Number of contactors	--	5	5
Ozone contact time (including quenching)	min	10	10
Ozone generator capacity, each	pounds per day (lb/day)	875	875
Number of ozone generators	--	2	2
Number of vaporizers	--	2	2
Capacity, each	gal	4,000	4,000
Liquid oxygen (LOX) tank capacity, each	gal	15,000	15,000
Number of LOX tanks	--	2	2
BAC System			
Number of filters (duty + standby)	--	7+1	7+1
Filter depth (granular activated carbon [GAC], sand)	in.	72, 12	72, 12
Design empty bed contact time (EBCT)(assumes 1 unit down)	min	14	14
Design loading rate (assumes 1 unit down)	Gallons per minute per square foot (gpm/ft^2)	4.3	4.3

Ozone and BAC design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

A.1.5 Ultrafiltration System

The UF system for this application consists of strainers followed by UF membranes. Design criteria for both are based on information provided by Pall, Inc. (Tables A-5 and A-6).

Table A-5. Strainer Design Criteria								
		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	Units	1a (GWR)	1b (RWA)	1c and1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Design feed flow	mgd	30.7	30.7	30.7	31.3	31.3	17.9	13.4
Number of strainers	--	5 duty, 1 standby	5 duty, 1 standby	5 duty, 1 standby	5 duty, 1 standby	5 duty, 1 standby	3 duty, 1 standby	3 duty, 1 standby
Design flow, each	mgd	6.1	6.1	6.1	6.3	6.3	6.0	4.5
Vessel material	--	316 SS	316 SS	316 SS	316 SS	316 SS	316 SS	316 SS
Min. screen pore size (nominal)	µm	300	300	300	300	300	300	300
Approximate strainer headloss, average	psi	5	5	5	5	5	5	5
Screen material	--	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)
Manufacturer	--	Pall	Pall	Pall	Pall	Pall	Pall	Pall

Strainer design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
SS = stainless steel

Table A-6. Pressure UF System Design Criteria								
		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	Units	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Manufacturer	--	Pall	Pall	Pall	Pall	Pall	Pall	Pall
Recovery	%	92%	92%	92%	92%	92%	92%	92%
Feed (all trains)	mgd	30.7	30.7	30.7	31.3	31.3	17.9	13.4
Reverse filtration flow, all trains (backwash)	mgd	2.5	2.5	2.5	2.5	2.5	1.4	1.1
Effluent (all trains)	mgd	28.2	28.2	28.2	28.8	28.8	16.5	12.4
Operation type (pressure/vacuum)	--	Pressure	Pressure	Pressure	Pressure	Pressure	Pressure	Pressure
Number of trains	--	9 duty, 1 standby	9 duty, 1 standby	9 duty, 1 standby	9 duty, 1 standby	9 duty, 1 standby	5 duty, 1 standby	4 duty, 1 standby
Design flux	gfd	20-30	50-60	50-60	20-30	20-30	20-30	20-30
Number of modules	per train	270	270	270	270	270	270	270
Number of modules	total	2,700	2,700	2,700	2,700	2,700	1,620	1,350
Operating transmembrane pressure, max.	psi	40	40	40	40	40	40	40
Cleaning frequency								
Maintenance clean	day	1	1	1	1	1	1	1
CIP	month	1	1	1	1	1	1	1

Pressure UF system design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
CIP = clean in place
gfd = gallons per square foot per day

A.1.6 Reverse Osmosis System

The RO system would consist of UF/RO interprocess tanks, RO transfer pumps, cartridge filters, RO feed pumps, and the RO treatment vessels. System details are based on information provided by Pall, Inc., and are described in Tables A-7 through A-11.

Table A-7. UF/RO Interprocess Tank Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
RO feed tank flow	mgd	28.2	28.2	28.2	28.8	28.8	16.5	12.4
Number of tanks	--	2	2	2	2	2	2	2
Design detention time	min	15	15	15	15	15	15	15
Operating volume, each	gal	169,200	169,200	169,200	169,200	169,200	95,200	82,900
Height	ft	18	18	18	18	18	18	18
Diameter	ft	40	40	40	40	40	30	28
Tank type	--	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade

UF/RO interprocess tank design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

Table A-8. RO Transfer Pump Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
RO feed flow, design	mgd	28.2	28.2	28.2	28.8	28.8	16.5	12.4
Type	--	Horizontal end suction	Horizontal end suction	Horizontal end suction	Horizontal end suction	Horizontal end suction	Horizontal end suction	Horizontal end suction
Number of pumps	--	4 duty, 1 standby	4 duty, 1 standby	4 duty, 1 standby	4 duty, 1 standby	4 duty, 1 standby	5 duty, 1 standby	4 duty, 1 standby
Capacity, each	gpm	5,000	5,000	5,000	5,000	5,000	2,600	2,600
TDH, each	ft	100	100	100	100	100	100	100
Motor size	hp	200	200	200	200	200	100	100
Pump efficiency	%	±80%	±80%	±80%	±80%	±80%	±80%	±80%
VFD	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes

RO transfer pump design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

Table A-9. RO Cartridge Filter Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Number of units[a]	quantity	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	6 duty, 0 standby	5 duty, 0 standby
Configuration	--	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel
Number of elements	per housing	220	220	220	220	220	220	220
Number of elements	total	2,200	2,200	2,200	2,200	2,200	1,320	1,110
Type	--	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal
Pore size	μm	5	5	5	5	5	5	5
Diameter	in.	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Length	in.	40	40	40	40	40	40	40
Design headloss, max.	psi	15	15	15	15	15	15	15

RO cartridge filter design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

a. Assumed all units are operating under normal operation but could manage the entire flow if one filter went out of service.

Table A-10. RO Feed Pumps Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Type	--	Vertical turbine	Vertical turbine	Vertical turbine	Vertical turbine	Vertical turbine	Vertical turbine	Vertical turbine
Number of pumps[a]	--	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	6 duty, 0 standby	5 duty, 0 standby
Capacity, each	gpm	2,179	2,179	2,179	2,222	2,222	2,288	2,145
Maximum design operation pressure	psi	300	300	300	300	300	300	300
Motor size	hp	500	500	500	500	500	500	500
Pump efficiency	%	±80%	±80%	±80%	±80%	±80%	±80%	±80%
VFD	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes

RO feed pump design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

a. Assumed all pumps are operating under normal operation but could manage the entire flow if one pump went out of service.

Table A-11. RO System Design Criteria

		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	Units	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
RO flow rates (total)	--							
Feed	mgd	28.2	28.2	28.2	28.8	28.8	16.5	12.4
RO concentrate	mgd	4.2	4.2	4.2	4.3	4.3	2.5	1.85
Permeate	mgd	24.0	24.0	24.0	24.5	24.5	14.0	10.5
Number of trains	--	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	6 duty, 0 standby	5 duty, 0 standby
Permeate per train	mgd	2.4	2.4	2.4	2.45	2.45	2.33	2.1
Train configuration								
Number of stages	--	3	3	3	3	3	3	3
Array configuration (per train)	pressure vessels by stage	45:25:13	45:25:13	45:25:13	45:25:13	45:25:13	45:25:13	45:25:13
Pressure vessels	per train	83	83	83	83	83	83	83
RO elements								
Type	--	Spiral wound	Spiral wound	Spiral wound	Spiral wound	Spiral wound	Spiral wound	Spiral wound
Material	--	TFC	TFC	TFC	TFC	TFC	TFC	TFC
Diameter	Inch (in)	8	8	8	8	8	8	8
Length	in	40	40	40	40	40	40	40
Area	sf	400	400	400	400	400	400	400
Number of elements	per pressure vessel	7	7	7	7	7	7	7
Number of elements	total	5,810	5,810	5,810	5,810	5,810	3,486	2,905
Nominal sodium chlorine reduction	%	>99.2%	>99.2%	>99.2%	>99.2%	>99.2%	>99.2%	>99.2%
Permeate TOC	mg/L	≤0.25	≤0.25	≤0.25	≤0.25	≤0.25	≤0.25	≤0.25
System recovery	%	85%	85%	85%	85%	85%	85%	85%
Anti-scalant to RO feed	mg/L	3	3	3	3	3	3	3
Sulfuric acid to RO feed	mg/L	6.1	6.1	6.1	6.1	6.1	6.1	6.1

RO system design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
TFC = thermo formable composite

A.1.7 Decarbonation/Air Stripping System

The RO permeate that feeds into the AOP has a high corrosivity that could corrode the product water conveyance pipelines depending on pipe material. To mitigate potential corrosion, decarbonation/air stripping towers are proposed to stabilize the product water through the removal of dissolved CO_2, which increases the pH of the water. This also reduces the level of chemical consumption associated with post treatment stabilization. The decarbonators/air strippers also help reduce water temperature to address aesthetics concerns and provide an additional mechanism of chemical control (volatilization) to complement other barriers. As currently configured, decarbonation is located upstream of the AOP due to the assumption that the UV system will use hydrogen peroxide, consistent with previous studies and the existing SVAWPC system. In many designs, decarbonation is either located downstream of UV-AOP or not included, depending on unconditioned treated water quality and final water quality goals. Relocation of decarbonation downstream of the UV-AOP to allow for flexibility in UV-AOP oxidant selection and optimize water stabilization is recommended for consideration. Table A-12 describes the decarbonator design criteria.

Table A-12. Decarbonator/Air Stripping Design Criteria

		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	Units	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Manufacture, model	--	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical
Number of units	--	4	4	4	4	4	3	2
Tank height	ft	14	14	14	14	14	14	14
Diameter	ft	12	12	12	12	12	11	12
Air flow rate, per unit	cfm	15,000	15,000	15,000	15,000	15,000	15,000	15,000
Blower size, per unit	hp	20	20	20	20	20	20	20
Treatment flow rate (each)	gpm	4,167	4,167	4,167	4,254	4,254	2,431	1,823
Loading rate, per unit	gpm/sf	37	37	37	37	37	26	20

Decarbonator/air stripper design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
cfm = cubic feet per minute
hp = horsepower

A.1.8 Advanced Oxidation Process System

The third treatment operation for these facilities is an AOP using UV light and hydrogen peroxide to provide the primary barrier against pathogenic organisms. Details for the proposed systems are described in Table A-13.

Table A-13. Advanced Oxidation Process Design Criteria

		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	Units	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Sodium bisulfite dose	mg/L	3	3	3	3	3	3	3
Hydrogen peroxide dose range	mg/L	3-5	3-5	3-5	3-5	3-5	3-5	3-5
UV system								
Manufacturer, model	--	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200
Number of units	--	2 duty, 1 standby	2 duty, 1 standby	2 duty, 1 standby	2 duty, 1 standby	2 duty, 1 standby	1 Duty, 1 Standby	1 duty, 1 standby
Configuration	--	In pipe, horizontal	In pipe, horizontal	In pipe, horizontal	In pipe, horizontal	In pipe, horizontal	In Pipe, Horizontal	In pipe, horizontal
Width	ft	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Length	ft	16.75	16.75	16.75	16.75	16.75	18.8	14.6
Lamp type	--	Low pressure, high output	Low pressure, high output	Low pressure, high output	Low pressure, high output	Low pressure, high output	Low pressure, high output	Low pressure, high output
Number of UV lamps	per unit	288	288	288	288	288	336	240
Number of duty UV lamps	total	576	576	576	576	576	336	240
UV lamp power	kW per lamp	1.0	1.0	1.0	1.0	1.0	1.0	1.0
UV reactor power	kW per unit	615	615	615	615	615	358	256
Total duty UV system power	kW	615	615	615	615	615	358	256
UVT (minimum, estimated)	%	96%	96%	96%	96%	96%	96%	96%
UV dose	mJ/cm^2	900	900	900	900	900	900	900

Advance oxidation process design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
kW = kilowatt
UVT = ultraviolet transmittance

A.1.9 Post Treatment Stabilization Process

After decarbonation, chemical addition completes the process of stabilizing purified water with estimated chemical dosing as presented in Table A-14.

Table A-14. Post-Treatment Stabilization and Chemical Requirements

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
LSI	--	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
Sodium hydroxide	mg/L	11	11	11	11	11	11	11
Lime	mg/L	12	12	12	12	12	12	12
Sodium hypochlorite[a]	mg/L	19	19	NA	19	19	19	19

Post treatment stabilization and chemical requirements for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

a. Sodium hypochlorite dose represents combined dose needed to quench residual hydrogen peroxide, achieve breakpoint chlorination, and provide free chlorine residual.

LSI = Langelier Saturation inex

A.1.10 Chlorine Disinfection Process

Based on the State Water Resources Control Board Division of Drinking Water's (DDW) current position on direct potable reuse (DPR), FAT is anticipated to be the minimum treatment baseline. Additional treatment elements will likely be needed to comply with stricter requirements for pathogen and chemical control. For TWA facilities, it was assumed that chlorine disinfection would form part of the minimum treatment requirements. Chlorine disinfection would provide another treatment barrier for viruses, and the residual free chlorine in the effluent flow from this process would safeguard against pathogen regrowth in downstream infrastructure. To receive 6/0/1 LRVs for this treatment step as discussed in D7, a minimum contact time (CT) of 37 min-mg/L is needed per *LT1ESWTR Disinfection Profiling and Benchmarking Technical Guidance Manual*. The design criteria for chlorine disinfection is provided in Table A-15.

Table A-15. Chlorine Disinfection Design Criteria for Portfolio 1c and 1d

Parameter	Units	San José/Santa Clara Regional Wastewater Facility
		1c and 1d (TWA)
Flow	mgd	24.0
CT	min-mg/L	37
Sodium Hypochlorite Dose[a]	mg/L	20
Basin		
Free Chlorine Residual	mg/L	3
Reactor Type	--	Plug-flow
Reactor Length to Width Ratio	--	20:1
Reactor Baffling Factor	%	70
Side Water Depth	ft	8
Freeboard	ft	2
Number of Passes	--	3
Length per Pass	ft	200
Width per Pass	ft	10
Reactor Volume	gal	360,000

Chlorine disinfection design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

a. Sodium hypochlorite dose represents combined dose needed to quench residual hydrogen peroxide, achieve breakpoint chlorination, and provide free chlorine residual.

A.1.11 Purified Water Storage Clearwell

Once the purified water has been stabilized and disinfected, it will be conveyed to an onsite baffled clearwell. The clearwell is designed with an 8-hour retention time and will provide the ability to respond to upstream performance and water quality issues, serve as a hydraulic buffer to manage demands in the distribution system, and provide a location to divert off-spec water upstream of distribution. Design criteria for the clearwell is provided in Table A-16.

Table A-16. Purified Water Storage Clearwell Design Criteria for Portfolio 1c and 1d

Parameter	Units	San José/Santa Clara Regional Wastewater Facility
		1c and 1d (TWA)
Purified Water Storage Tank		
Manufacturer	--	DN Tanks
Number of Tanks	--	2
Inside Diameter	ft	134
Side Water Depth	ft	39
Volume	gal	4,000,000
Freeboard	ft	5

Purified water storage clearwell design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

A.1.12 UF Backwash Disposal

The types and flow rates of waste streams is summarized in Table A-17 for each AWPF. Design criteria for the waste equalization wetwell are presented in Table A-18.

Table A-17. Waste Side-Stream Flows

			Flow (mgd)						
			SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Waste Stream	Frequency	Percent of Feed Flows	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Strainer cleaning flows	Intermittent	<1% of facility influent flow	0.3	0.3	0.3	0.3	0.3	0.2	0.2
UF backwash waste flows	Intermittent	~8% of facility influent flow	2.5	2.5	2.5	2.6	2.6	1.3	1.3
RO concentrate flows	Continuous	~15% of RO feed flow	4.5	4.5	4.5	4.6	4.6	2.7	2.0
CIP solution flows	Intermittent	NA	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Waste side-stream flows for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

Table A-18. Waste Equalization Design Criteria

		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	Units	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Wetwell volume	gal	219,000	219,000	219,000	201,000	201,000	135,800	105,300
Minutes of UF waste storage	min	90	90	90	90	90	90	90
Pump station								
Pump type	--	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump
Number of pumps	--	3 Duty, 1 Standby	3 Duty, 1 Standby	3 Duty, 1 Standby	3 Duty, 1 Standby	3 Duty, 1 Standby	2 Duty, 1 Standby	3 Duty, 1 Standby
Design flow, each	gpm	1,800	1,800	1,800	694	694	694	347
TDH	ft	35	35	35	34	32	32	21
Motor size	hp	40	40	40	10	10	10	3
VFD	--	No	No	No	TBD	TBD	TBD	TBD
Pipeline								
Pipeline diameter	in.	24	24	24	14	14	10	10
Pipeline length	LF	3,000	2,875	2,875	1,200	500	1,200	500
Pipeline material (match existing)	--	HDPE Pressure Pipe	Mortar Lined and Coated Steel Pipe	Mortar Lined and Coated Steel Pipe	HDPE Pressure Pipe	HDPE Pressure Pipe	HDPE Pressure Pipe	HDPE Pressure Pipe

Waste equalization design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

HDPE = high-density polyethylene

A.2 Morgan Hill Satellite and AWPF Design Criteria

A.2.1 Influent Pump Station

The influent pump station was designed to handle a peak flow of 4.5 mgd and an average flow of 2.5 mgd. AFT Fathom (fluid dynamic simulation software) was used to determine the head and pump size. Table A-19 presents design criteria for the influent pump station.

Table A-19. Influent Pump Station Design Criteria

Parameter	Units	Value
Feed flow	mgd	4.5
Number of pumps	--	2 duty, 1 standby
Type	--	Submersible non-clog
Capacity, each	gpm	1,600
TDH, each	ft	10.2
Motor size	hp	7.5
Pump efficiency	%	70%
VFD	--	Yes

A.2.2 Headworks

The headworks layout consists of coarse screens, grit removal, fine screens, and associated facilities. The coarse and fine screens are important for protecting the downstream membranes and the grit chamber and for reducing grit buildup in the downstream biological reactors. The coarse screens are spiral screen with two duty and one bypass unit. A spiral screen was chosen due to its relatively compact footprint. The grit removal system is a mechanical vortex system chosen for its low energy cost and efficient removal at variable speeds. The fine screens are an internally fed rotary drum with two duty and one standby unit. The headworks were designed to handle a peak flow of 4.5 mgd and sized using industry standards and previous project designs. Table A-20 presents design criteria for the headworks.

Table A-20. Headworks Design Criteria		
Parameter	Units	Value
Coarse screen		
Type	--	Submersible non-clog; spiral screen
Number	--	2 duty with bypass
Opening size	mm	6
Capacity (each)	mgd	2.25
Conveyor type	--	Shaftless screw
Compactor type	--	Screw compactor
Grit removal		
Type	--	Mechanical Vortex
Number	--	2 duty with bypass
Capacity (each)	mgd	2.25
Conveyor type	--	Screw Press
Fine screens		
Type	--	Internally fed rotary drum
Number	--	2 duty, 1 standby
Opening size	mm	2
Capacity (each)	mgd	2.25
Motor size	hp	0.5

A.2.3 Equalization Basin and Intermediate Pump Station

The equalization basin, which is envisioned as a partially buried concrete structure, would capture and balance diurnal peak flows upstream of treatment. As Morgan Hill flow data are not available, a typical diurnal curve[1] for small systems was used to estimate the storage required for an average flow of 2.5 mgd. The estimated volume for the facility was 0.22 MG, including a 15 percent safety factor. The intermediate pump station pumps flow to the membrane bioreactor (MBR) system and was sized using AFT Fathom. Tables A-21 and A-22 present design criteria for the equalization basin and intermediate pump station.

Table A-21. Equalization Basin Design Criteria		
Parameter	Units	Value
Width x length	ft x ft	35 x 45
Operating water range	ft	22
Freeboard above max water level	ft	2
Tank height	ft	24
Equalization volume	MG	0.22

---

[1] Crites & Tchobanoglous, Small and Decentralized Wastewater Management Systems,

Table A-22. Intermediate Pump Station Design Criteria		
Parameter	**Units**	**Value**
Type	--	Submersible non-clog
Number	--	2 duty, 1 standby
Capacity (each)	gpm	1,600
TDH	ft	10.2
Motor size	hp	7.5

A.2.4 Membrane Bioreactor System

The MBR process uses a membrane filter for liquid/solids separation to produce tertiary effluent. This process does not require secondary clarifiers or tertiary filters because the membranes achieve clarification/filtration in one step. The biological nutrient removal (BNR) basins will consist of a de-oxygenation zone so that residual dissolved oxygen (DO) from the membrane tanks will be consumed biologically, followed by a baffled anoxic zone then an aeration zone. The MBR system will be designed with two parallel BNR basins and three parallel membrane tanks. The MBR system criteria was developed using a process modeling software called BioWin 6.0. The main model input values include influent flow, biological oxygen demand (BOD), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), total phosphorus, and temperature. The model indicated a needed aeration basin volume of 0.52 MG and return activated sludge pumps operated at 400 percent of influent flow. Table A-23 presents design criteria for the membrane bioreactor system.

Table A-23. Bioreactor System Design Criteria		
Parameter	**Units**	**Value**
Mixed liquor suspended solids (MLSS)	mg/L	7,100
Mean cell residence time (MCRT) (solids retention time [SRT]) at average flow	days	10
Number of trains	--	2
Number of pre-anoxic basins	--	2
Volume, total	MG	0.24
Width x length (each basin)	ft x ft	20 x 45
Water depth (per train)	ft	18
Number of aeration basins (per train)	--	2
Volume, total	MG	0.48
Width x length (each basin)	ft x ft	20 x 90
Water depth	ft	18
Number of de-oxygenation basins (per train)	--	2
Volume, total	gal	50,000
Width x length (each basin)	ft x ft	20 x 10
Water depth	ft	18
Membrane reactor		
Total volume	MG	0.09
Cassettes per train	ft	10
Chloramination		
Hypochlorite dose for chloramine residual	mg/L	1.5
Aqueous ammonia Dose for chloramine residual	mg/L	0.5

A.2.5 Blowers and Mixers

Blowers and mixers are used as part of the MBR system to move continuously mixed fluid through the tanks and prevent settling. Sizing needed for air requirements were made from a Brown and Caldwell (BC) standardized spreadsheet. Table A-24 presents design criteria for the blowers and mixers.

Table A-24. Blowers and Mixers Design Criteria

Parameter	Units	Value
Aeration blowers		
Standard cubic feet per minute (scfm) (each)	--	7,000
Number of blowers	--	2 duty, 1 standby
TDH	psi	10
Motor size	hp	220
Mixers	--	2
Number	--	2 duty
Motor size	hp	1

A.2.6 RAS/WAS Pump Systems

The return activated sludge (RAS) pumps return sludge from the membrane area to the head of the process train at the deoxygenation basin. Waste activated sludge (WAS) pumps send waste sludge from the end of the process to a waste wetwell that will connect to a trunk sewer. The pumps were sized using the following equation with an assumed head of 5 feet, efficiency of 70 percent, and individual design flows:

$$hp = (flow \times head)/(3960 \times efficiency).$$

Table A-25 presents design criteria for the RAS and WAS pumps.

Table A-25. RAS and WAS Pumps Design Criteria

Parameter	Units	Value
Mixed liquor recycle pumps (RAS)		
Number	--	2 duty, 1 standby
Capacity (each)	gpm	6,944
TDH	ft	5
Motor size	hp	15
Waste activated sludge pumps (WAS)		
Number	--	2 duty, 1 standby
Capacity (each)	gpm	65
TDH	ft	5
Motor size	hp	1

A.2.7 RO System

The main components of the RO system consist of cartridge filters, feed pumps within the RO wetwell, RO unit (including skids), CIP system with tanks and RO pumps, and permeate flush tanks. The RO system was designed around a flux of 12 gfd and RO recovery of 85 percent. Design criteria for the RO system are presented in Tables A-26 through A-31.

Table A-26. RO Interprocess Tank Design Criteria

Parameter	Units	Value
RO feed tank flow	mgd	2.5
Flux	gfd	12
RO recovery rate	%	85%
No. of tanks	--	1
Design detention time	min	15
Operating volume, each	gal	26,042
Height	ft	10
Diameter	ft	30
Tank type	--	Steel, cylindrical, above grade

Table A-27. RO Transfer Pump Design Criteria

Parameter	Units	Value
RO feed flow	mgd	2.5
Type	--	Horizontal end suction
No. of Pumps	--	1 duty, 1 standby
Capacity, each	gpm	1,736
TDH, each	ft	45
Motor size	hp	2
Pump efficiency	%	±80%
VFD	--	Yes

Table A-28. RO Cartridge Filter Design Criteria

Parameter	Units	Value
No. of units	--	2 duty
Configuration	--	Parallel
No. of elements (per housing)	per housing	62
No. of elements (total)	total	124
Type	--	Melt blown polypropylene or equal
Pore size	μm	5
Vessel diameter	in.	27
Length	in.	40
Design headloss, max	psi	15

Table A-29. RO Feed Pump Design Criteria		
Parameter	**Units**	**Value**
Type	--	Vertical turbine
No. of pumps	--	2 duty
Capacity, each	gpm	858
TDH, each	psi	260
Motor size	hp	210
Pump efficiency	%	80%
VFD	--	Yes

Table A-30. RO System Design Criteria		
Parameter	**Units**	**Value**
RO flow rates (total)		
Feed	mgd	2.5
RO concentrate	mgd	0.4
Permeate	mgd	2.1
RO system recovery rate	%	85
No. of trains	---	2 duty
Permeate per train	mgd	1.05
Train configuration	--	--
No. of stages	---	3
Array configuration (per train)	pres. vessels by stage	20:10:05
Pressure vessels	per train	35
Stage 3 boost pumps		
Number of pumps	---	1
Motor size, each	hp	40
TDH boost	pounds per square inch (psi)	30
RO element data		
Type	---	Spiral wound
Diameter	in.	8
Length	in.	40
No. of elements	per pressure vessel	7
No. of elements	total	245
Nominal sodium chloride rejection	---	>99.2%
Permeate TOC	mg/L	≤0.25
Anti-scalant to RO feed	mg/L	3
Sulfuric Acid to RO feed	mg/L	6.1

Table A-31. RO CIP System		
Parameter	**Units**	**Value**
CIP flow rate	gpm	800
CIP pump head	psig	60
CIP horsepower	hp	20
CIP tank diameter	ft	7
CIP frequency (per year)	--	6

A.2.8 Decarbonation System

Table A-32 describes the decarbonator design criteria for the Morgan Hill AWPF.

Table A-32. Decarbonation Criteria		
Parameter	**Units**	**Value**
Decarbonator towers		
Manufacturer	--	Daniel Mechanical
No. of units	--	1
Tank height	ft	14
Diameter	ft	8
Air flow rate, per unit	cfm	15,000
Blower size, per unit	hp	20
Treatment flow rate (each)	gpm	1,458
Loading rate, per unit	gpm/sf	29

A.2.9 Advanced Oxidation Process (UV/AOP) System

UV/AOP uses high-intensity ultraviolet light combined with an oxidant such as chlorine or hydrogen peroxide for destruction of many contaminants of emergency concern(CEC). Hydrogen peroxide is the assumed oxidant in this analysis. UV/AOP system was designed to meet the design requirements effective for disinfection, providing up to 6-log inactivation of viruses, *Cryptosporidium*, and *Giardia*. Table A-33 presents the design criteria for the UV/AOP system.

Table A-33. UV/AOP Criteria

Parameter	Units	Value
Sodium bisulfite dose	mg/L	3
Hydrogen peroxide dose	mg/L	2.8
UV system		
Manufacturer, model	--	TrojanUV, Flex 200
Number of units	--	1 duty, 1 standby
Configuration	--	In pipe, horizontal
Width	ft	8.33
Length	ft	10.25
Lamp type	--	Low pressure, high output
Number of UV lamps	per unit	72
Number of duty UV lamps	total	72
UV lamp power	kW per lamp	0.72
UV reactor power	kW per unit	52
Total duty UV system power	kW	52
UVT (minimum, estimated)	%	96%
UV dose	mJ/cm^2	900

mJ/cm_2 = millijoule per square centimeter

A.2.10 Post-Treatment Stabilization Process

Product water stabilization is necessary to prevent corrosion of the distribution system after RO treatment. Under the assumed treatment strategy, the use of decarbonation is the initial step to treat the treated effluent, and the addition of both sodium hydroxide and lime would help complete the stabilization process. The addition of sodium hydroxide increases pH and calcium chloride increases mineral content. Table A-34 presents design criteria for the post-treatment stabilization process.

Table A-34. Post-Treatment Stabilization and Chemical Requirements

Parameter	Units	Value
LSI	--	0-0.5
Sodium hydroxide	mg/L	11
Lime	mg/L	12

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Appendix A-4: Preliminary Project Designs

Process Flow Diagrams

Site Layouts

Notes regarding site layouts and process flow diagrams for three potential facilities:

- Palo Alto NPR+ AWPF: Prepared by MNS Engineers, Inc. as part of the Advanced Water Purification System Preliminary/Conceptual Design Report
- Sunnyvale NPR+ AWPF: Mirrors the concept developed for the Palo Alto NPR+ AWPF and not included as part of this attachment
- New or expanded SJ/SC NPR+ facility: Mirrors that of the existing SVAWPC. Thus, the SVAWPC site layout and process flow diagram are included in this attachment to provide a basis.

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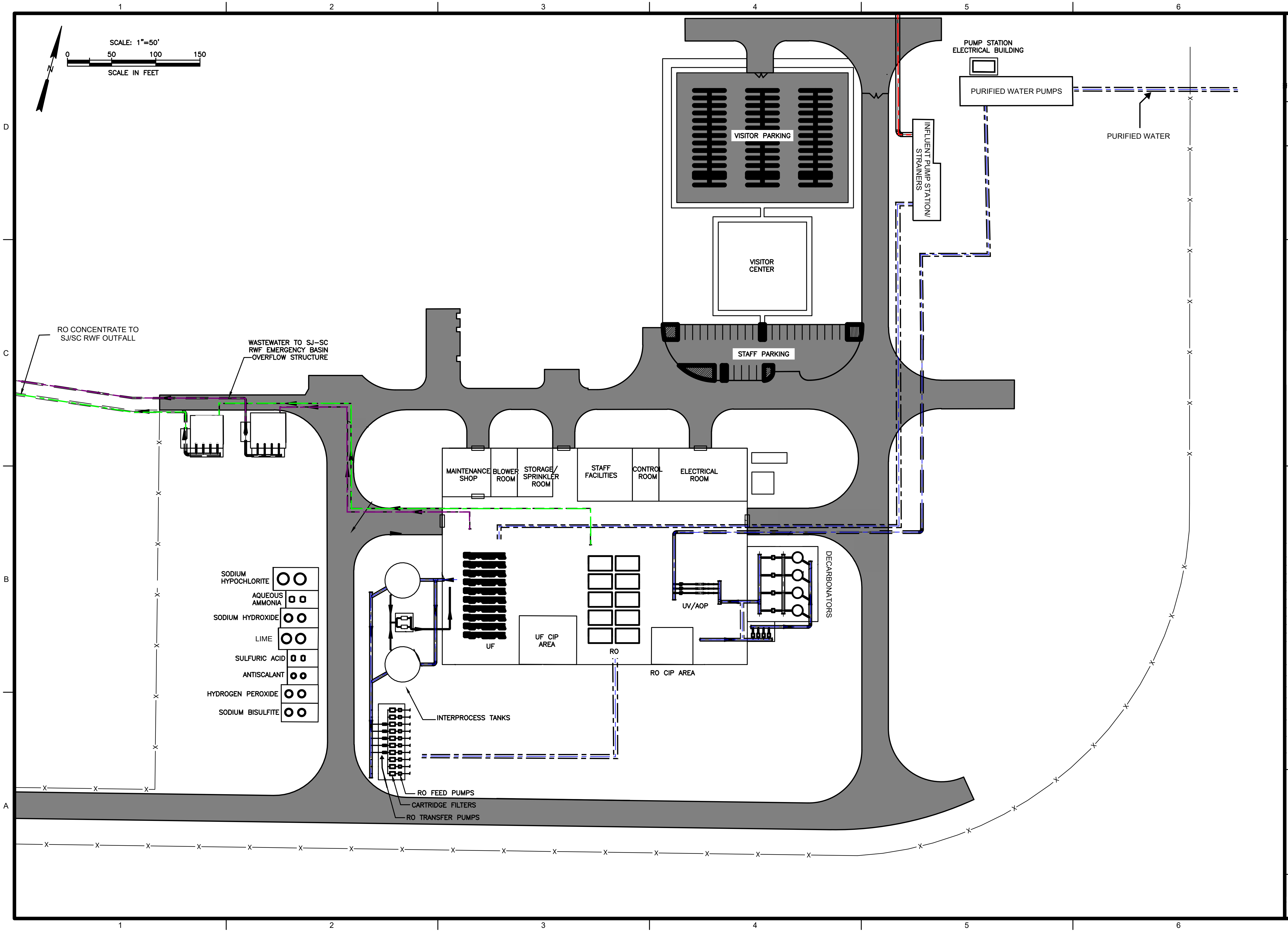


Brown AND Caldwell

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

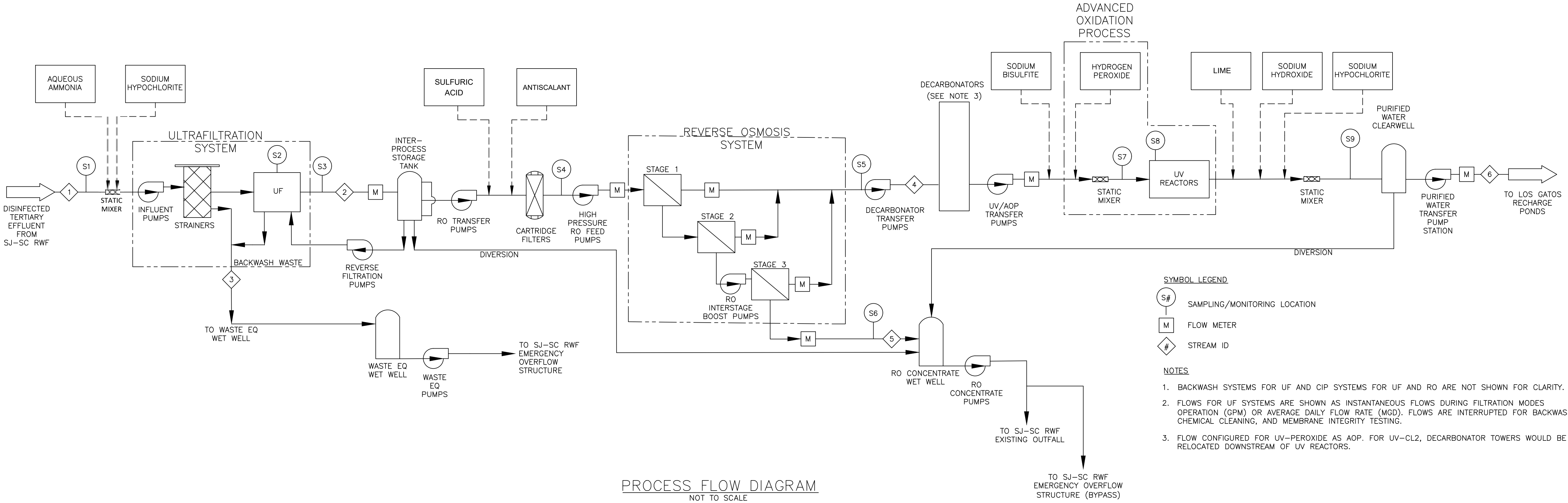
Valley Water

GENERAL

SAN JOSE/ SANTA CLARA
24 MGD AWPF

PORTFOLIO 1A

DRAWING NUMBER
1 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇ #	STREAM ID

NOTES

1. BACKWASH SYSTEMS FOR UF AND CIP SYSTEMS FOR UF AND RO ARE NOT SHOWN FOR CLARITY.
2. FLOWS FOR UF SYSTEMS ARE SHOWN AS INSTANTANEOUS FLOWS DURING FILTRATION MODES OPERATION (GPM) OR AVERAGE DAILY FLOW RATE (MGD). FLOWS ARE INTERRUPTED FOR BACKWASH, CHEMICAL CLEANING, AND MEMBRANE INTEGRITY TESTING.
3. FLOW CONFIGURED FOR UV-PEROXIDE AS AOP. FOR UV-CL2, DECARBONATOR TOWERS WOULD BE RELOCATED DOWNSTREAM OF UV REACTORS.

PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
◇ 1	30.7	21,300
◇ 2	28.2	19,600
◇ 3	2.46	1,700
◇ 4	24.0	16,700
◇ 5	4.24	2,900
◇ 6	24.0	16,700

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Valley Water

GENERAL

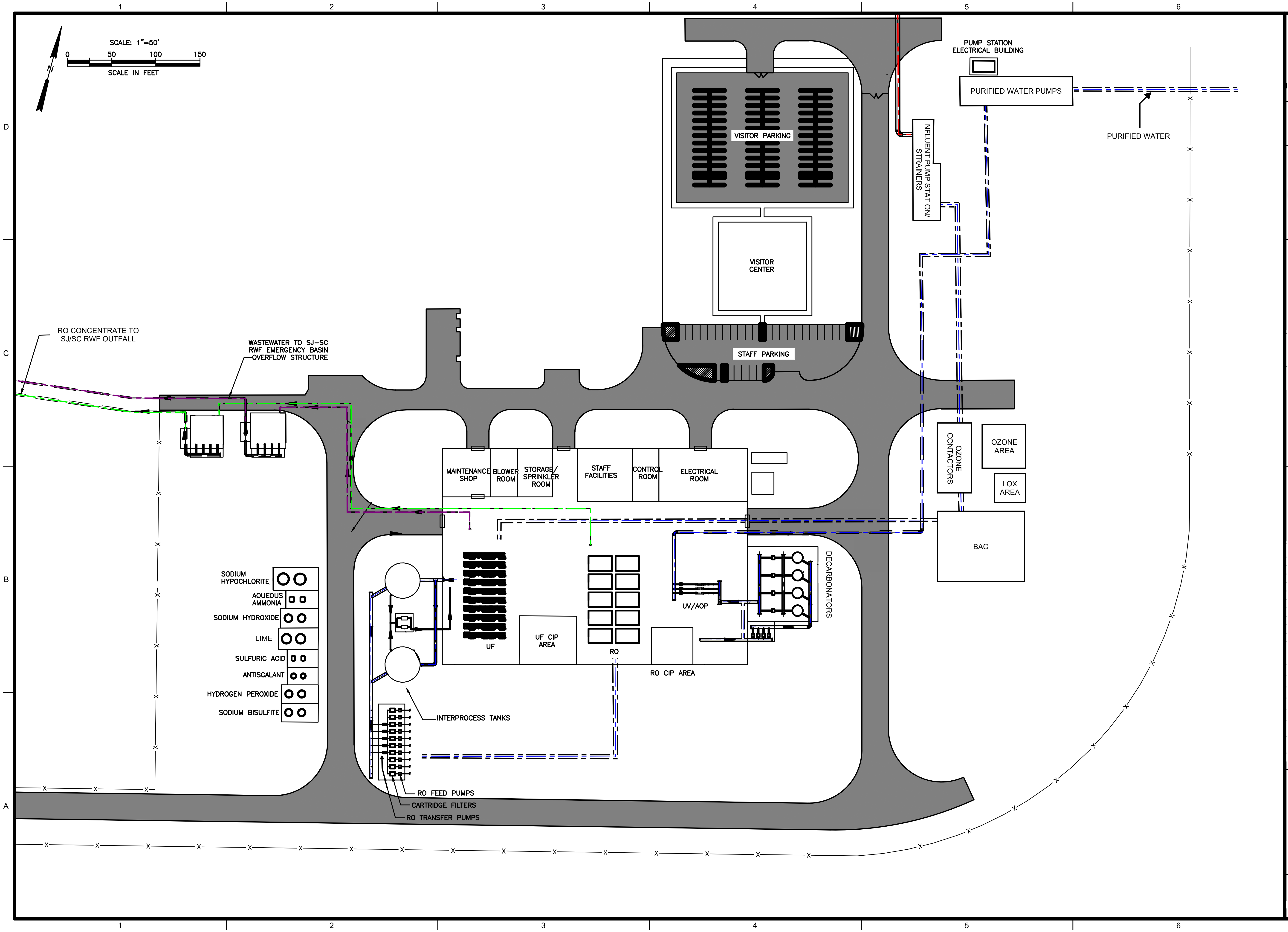
SAN JOSE/SANTA CLARA 24 MGD AWPF

PORTFOLIO 1A

PROCESS FLOW DIAGRAM

DRAWING NUMBER

2 OF 23



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SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

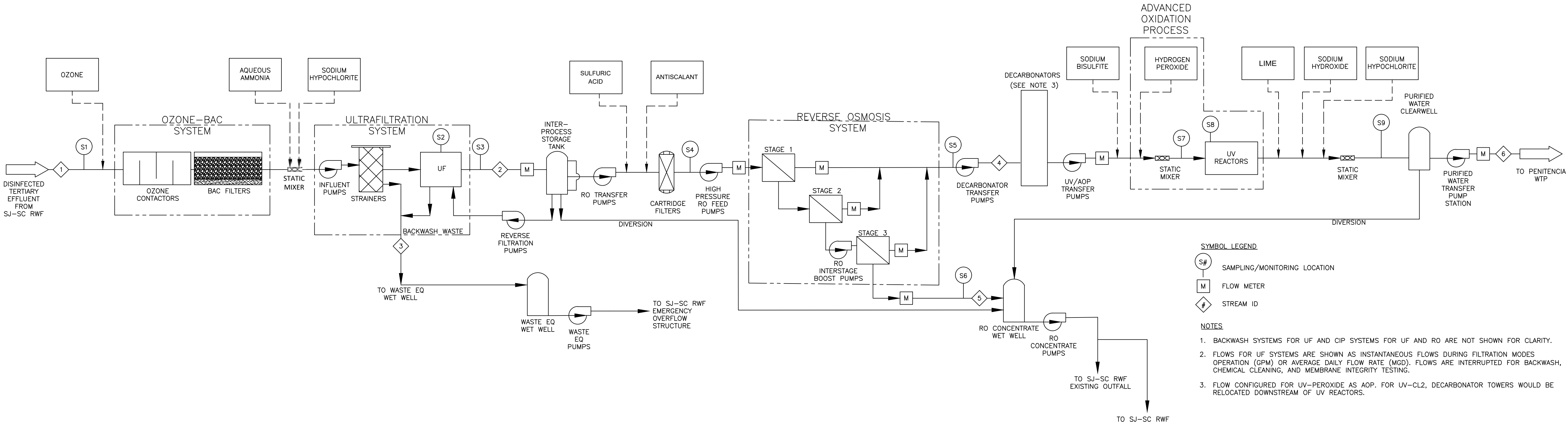
GENERAL

SAN JOSE/ SANTA CLARA
24 MGD AWPF FOR RWA

PORTFOLIO 1B

DRAWING NUMBER

3 OF 23



PROCESS FLOW DIAGRAM
NOT TO SCALE

SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇#	STREAM ID

NOTES

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3. FLOW CONFIGURED FOR UV–PEROXIDE AS AOP. FOR UV–CL2, DECARBONATOR TOWERS WOULD BE RELOCATED DOWNSTREAM OF UV REACTORS.

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
◇1	30.7	21,300
◇2	28.2	19,600
◇3	2.46	1,700
◇4	24.0	16,700
◇5	4.24	2,900
◇6	24.0	16,700

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WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

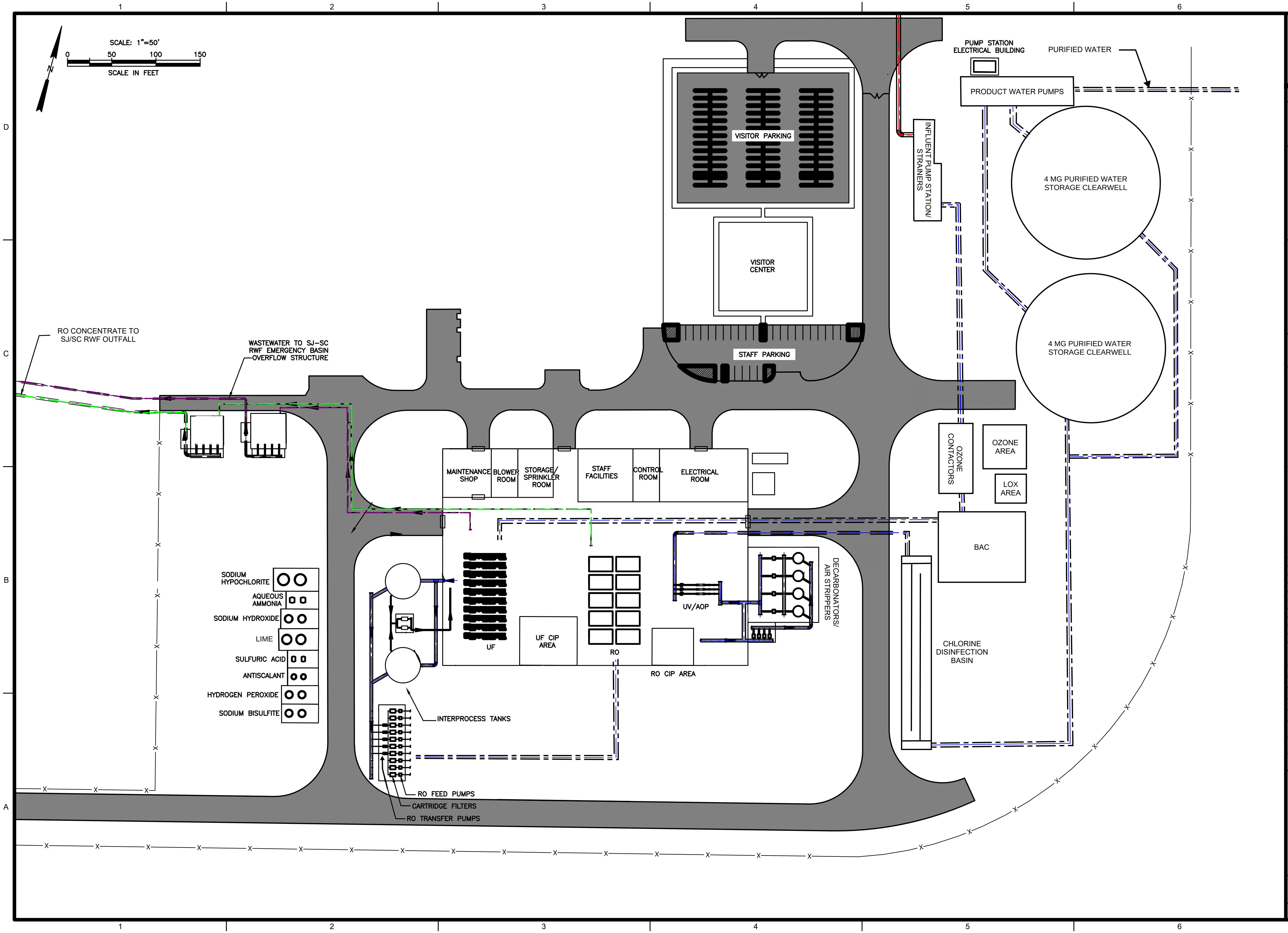
GENERAL

SAN JOSE/SANTA CLARA 24
MGD AWPF

PORTFOLIO 1B

PROCESS FLOW DIAGRAM

DRAWING NUMBER
4 OF 23



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SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

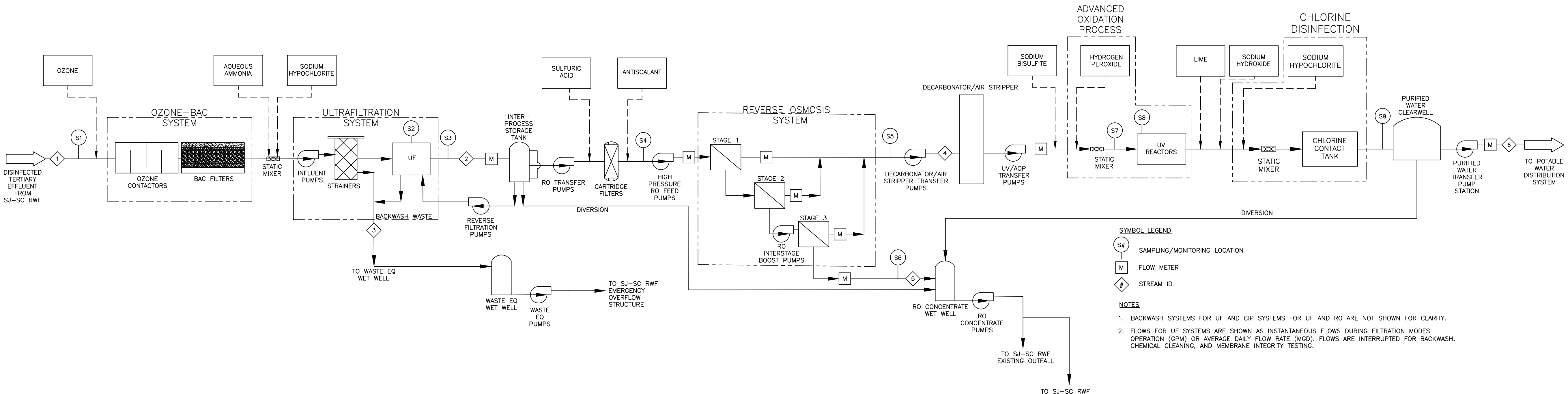
GENERAL

SAN JOSE/ SANTA CLARA
24 MGD AWPF FOR TWA

PORTFOLIO 1C and 1D

DRAWING NUMBER

5 OF 23



PROCESS FLOW DIAGRAM
NOT TO SCALE

SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
#	STREAM ID

NOTES

1. BACKWASH SYSTEMS FOR UF AND CIP SYSTEMS FOR UF AND RO ARE NOT SHOWN FOR CLARITY.
2. FLOWS FOR UF SYSTEMS ARE SHOWN AS INSTANTANEOUS FLOWS DURING FILTRATION MODES OPERATION (GPM) OR AVERAGE DAILY FLOW RATE (MGD). FLOWS ARE INTERRUPTED FOR BACKWASH, CHEMICAL CLEANING, AND MEMBRANE INTEGRITY TESTING.

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	30.7	21,300
2	28.2	19,600
3	2.5	1,700
4	24.0	16,700
5	4.2	2,900
6	24.0	16,700

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SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

GENERAL

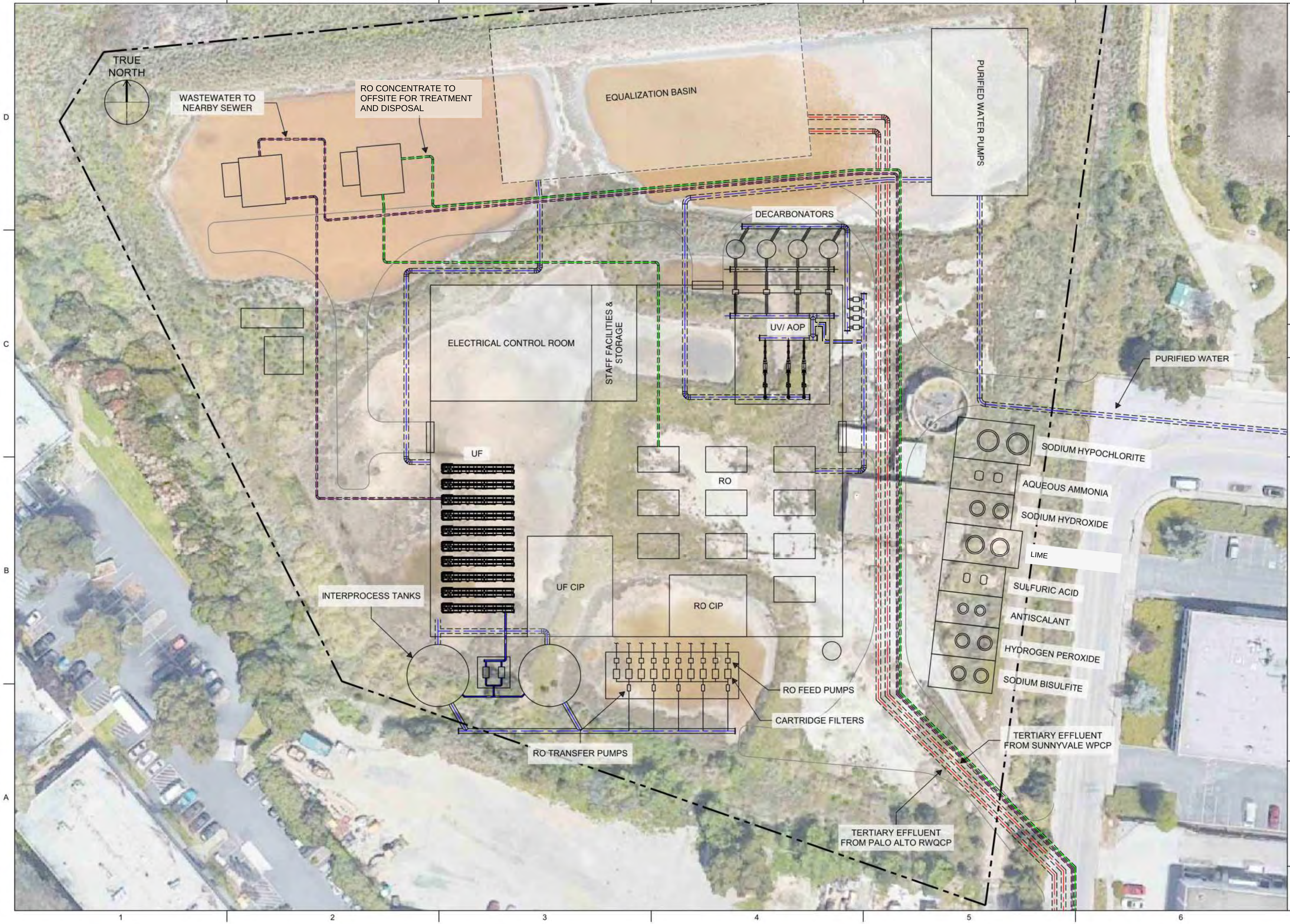
SAN JOSE/ SANTA CLARA
24 MGD AWPF FOR TWA

PORTFOLIO 1C AND 1D

PROCESS FLOW DIAGRAM

DRAWING NUMBER

6 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

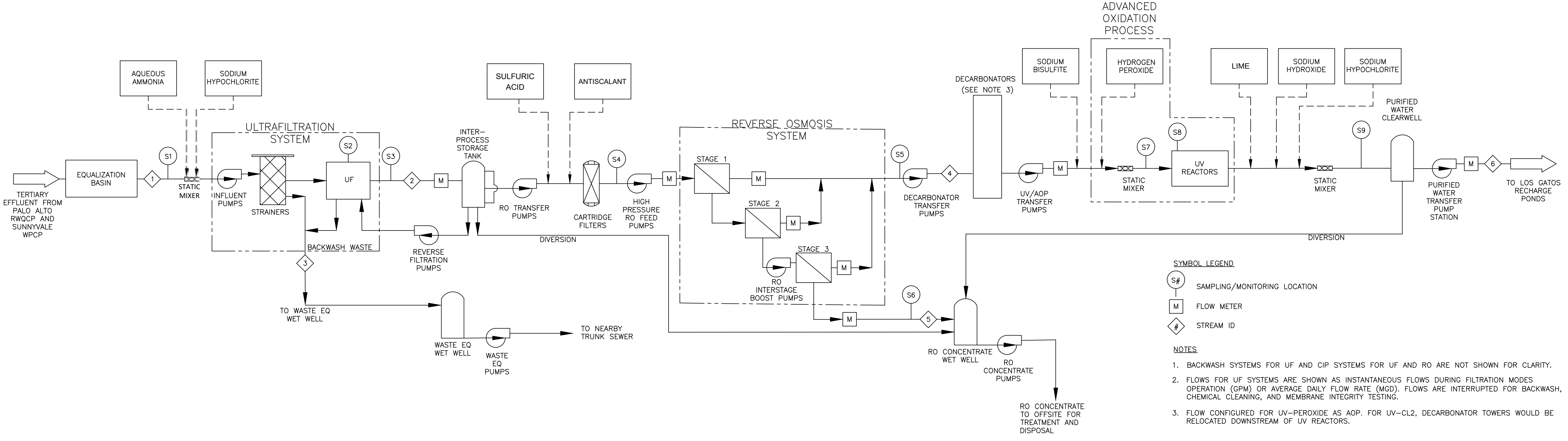
Valley Water

GENERAL

PALO ALTO 24.5 MGD
COMBINED REGIONAL AWPF

PORTFOLIO 2A

DRAWING NUMBER
7 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
#	STREAM ID

NOTES

1. BACKWASH SYSTEMS FOR UF AND CIP SYSTEMS FOR UF AND RO ARE NOT SHOWN FOR CLARITY.
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PROCESS FLOW DIAGRAM
NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	31.3	21,700
2	28.8	20,000
3	2.50	1,700
4	24.5	17,000
5	4.32	3,000
6	24.5	17,000

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SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

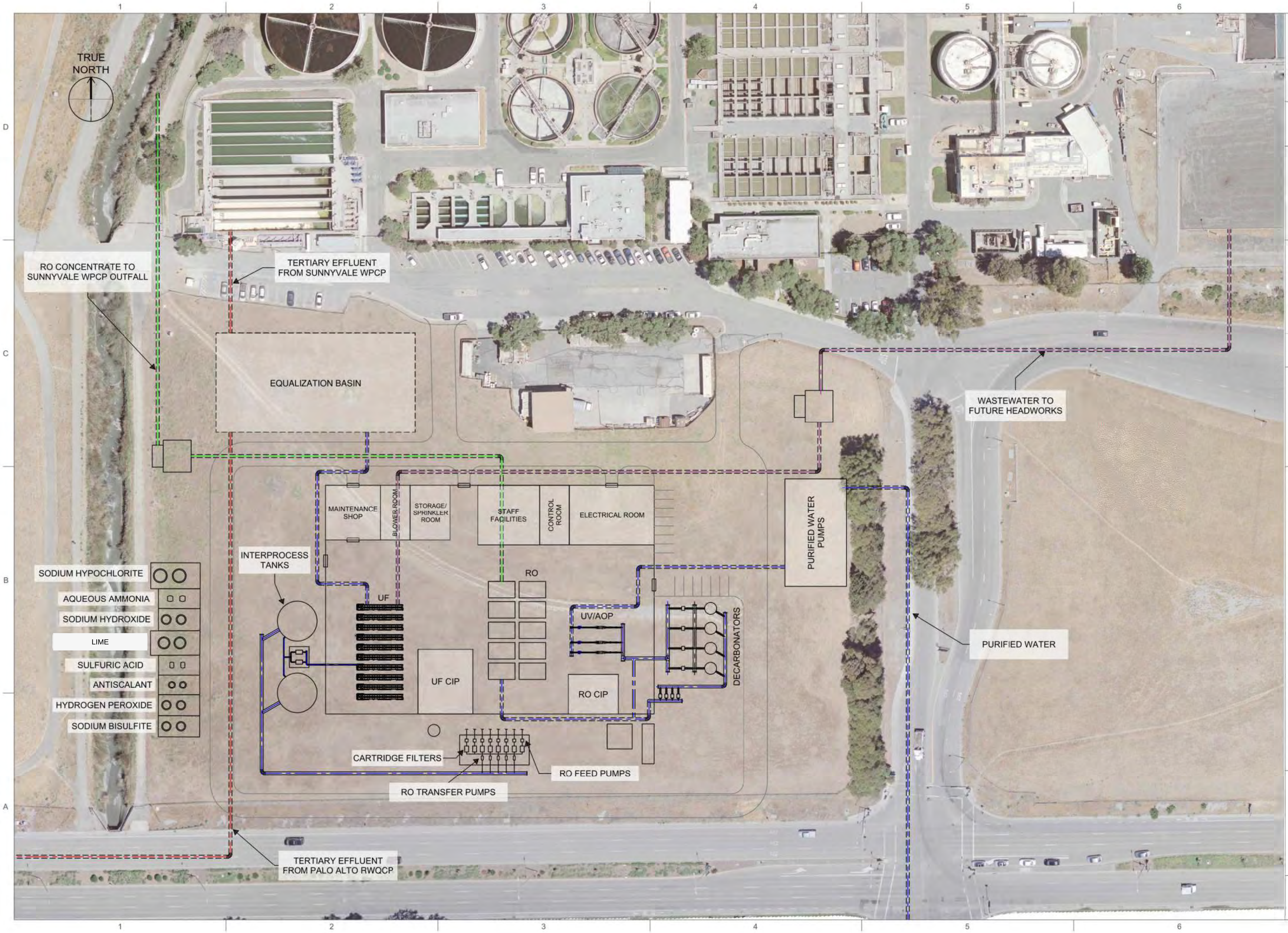
GENERAL

PALO ALTO 24.5 MGD
COMBINED REGIONAL AWPF

PORTFOLIO 2A

PROCESS FLOW DIAGRAM

DRAWING NUMBER
8 OF 23



Brown and Caldwell

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

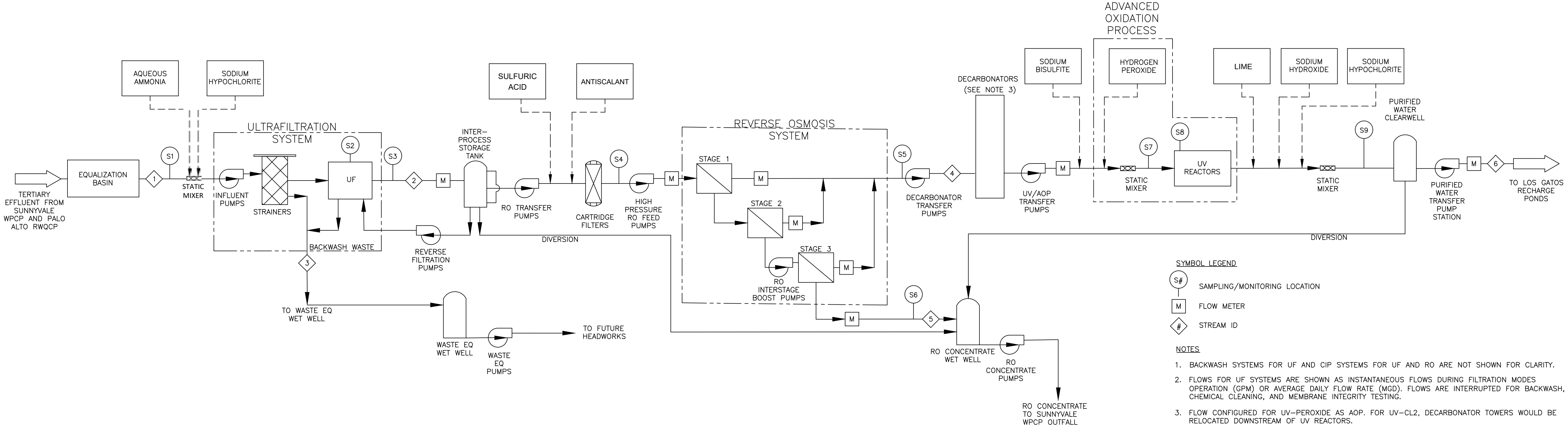
GENERAL

SUNNYVALE 24.5 MGD COMBINED REGIONAL AWPF

PORTFOLIO 2B

DRAWING NUMBER

9 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇#	STREAM ID

NOTES

1. BACKWASH SYSTEMS FOR UF AND CIP SYSTEMS FOR UF AND RO ARE NOT SHOWN FOR CLARITY.
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3. FLOW CONFIGURED FOR UV–PEROXIDE AS AOP. FOR UV–CL2, DECARBONATOR TOWERS WOULD BE RELOCATED DOWNSTREAM OF UV REACTORS.

PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	31.3	21,700
2	28.8	20,000
3	2.50	1,700
4	24.5	17,000
5	4.32	3,000
6	24.5	17,000

Brown AND Caldwell

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

GENERAL

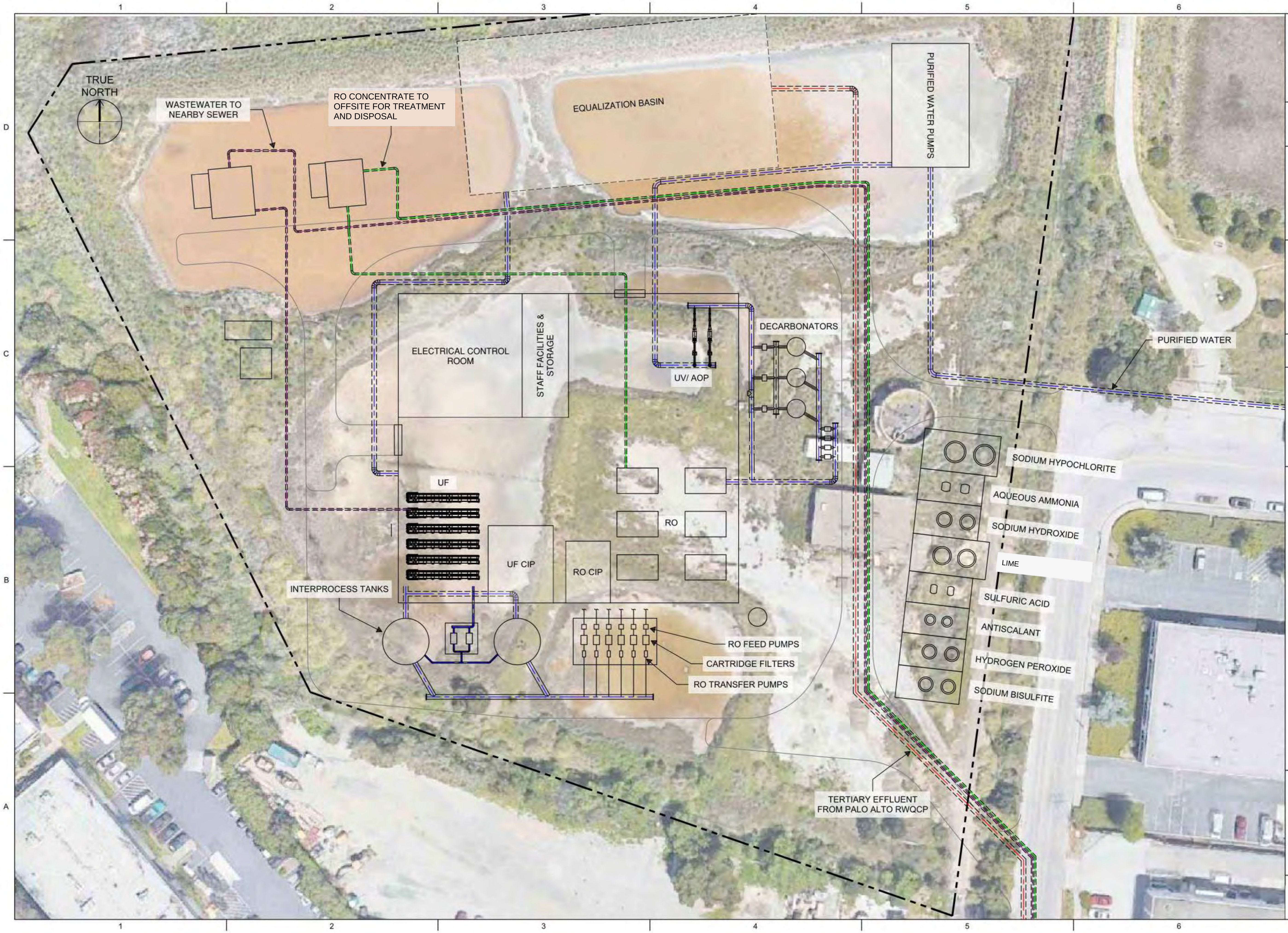
SUNNYVALE 24.5 MGD
COMBINED REGIONAL AWPF

PORTFOLIO 2B

PROCESS FLOW DIAGRAM

DRAWING NUMBER

10 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

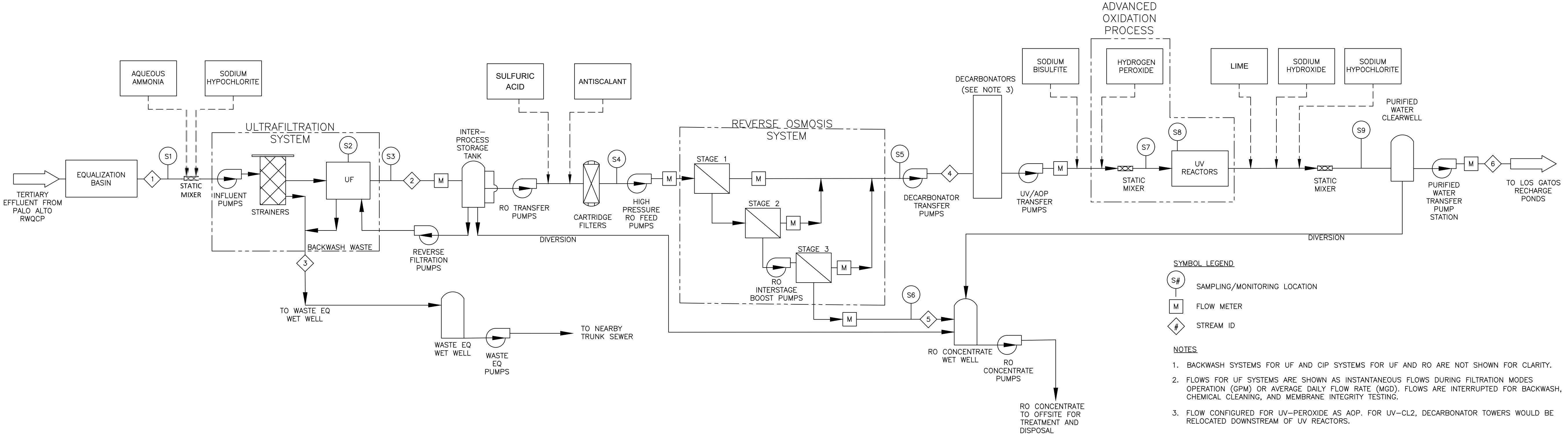
GENERAL

PALO ALTO 14 MGD REGIONAL AWPF

PORTFOLIO 4A

DRAWING NUMBER

11 OF 23



NOTES

1. BACKWASH SYSTEMS FOR UF AND CIP SYSTEMS FOR UF AND RO ARE NOT SHOWN FOR CLARITY.
2. FLOWS FOR UF SYSTEMS ARE SHOWN AS INSTANTANEOUS FLOWS DURING FILTRATION MODES OPERATION (GPM) OR AVERAGE DAILY FLOW RATE (MGD). FLOWS ARE INTERRUPTED FOR BACKWASH, CHEMICAL CLEANING, AND MEMBRANE INTEGRITY TESTING.
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PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	17.9	12,400
2	16.5	11,400
3	1.43	1,000
4	14.0	9,700
5	2.47	1,700
6	14.0	9,700

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

GENERAL

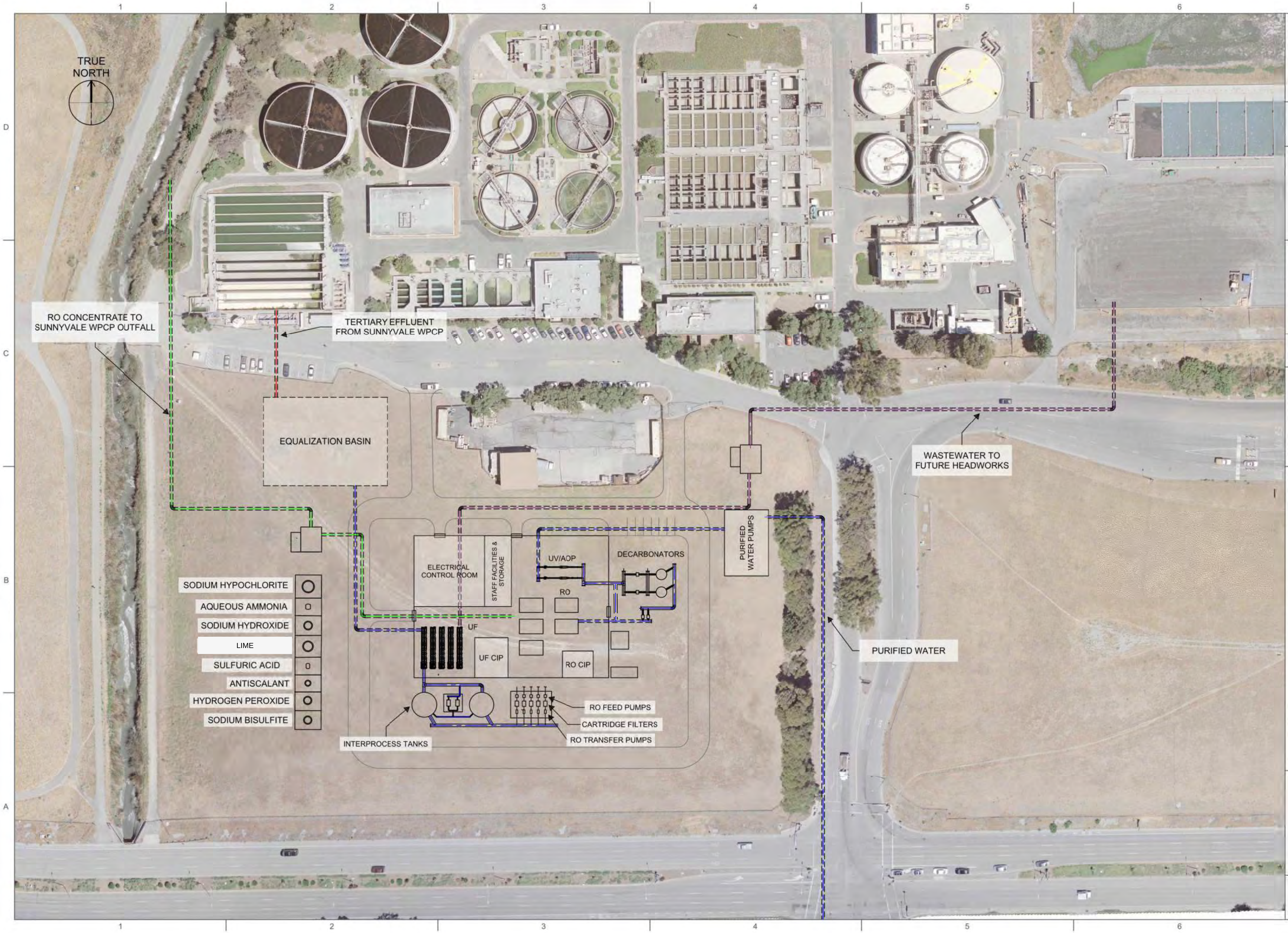
PALO ALTO 14 MGD
REGIONAL AWPF

PORTFOLIO 4A

PROCESS FLOW DIAGRAM

DRAWING NUMBER

12 OF 23



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SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

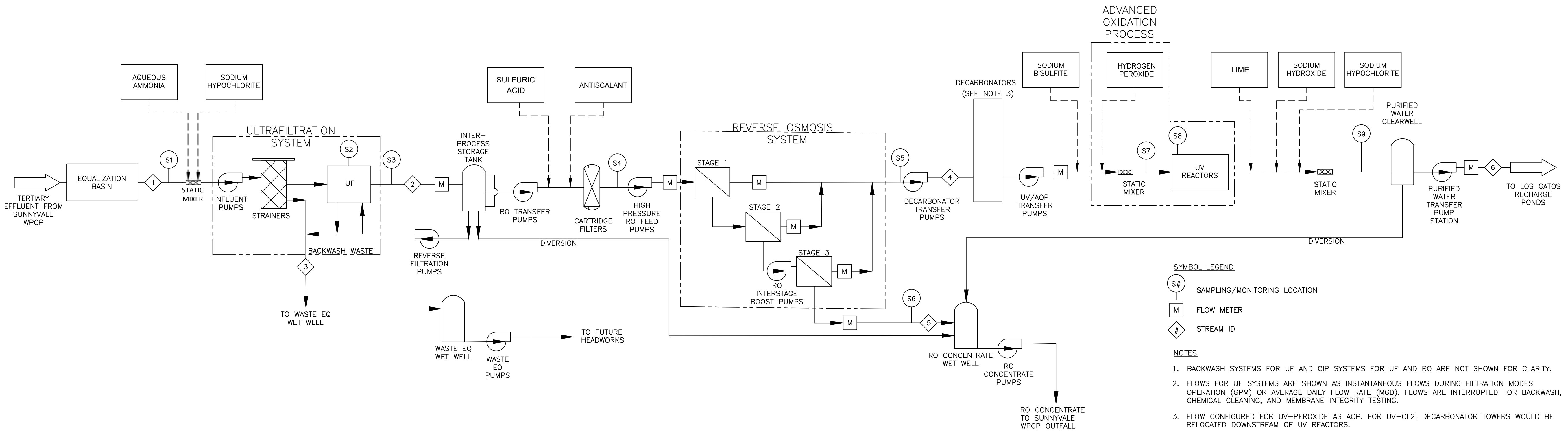
GENERAL

SUNNYVALE 10.5 MGD
REGIONAL AWPF

PORTFOLIO 4B

DRAWING NUMBER

13 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇#	STREAM ID

NOTES

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3. FLOW CONFIGURED FOR UV–PEROXIDE AS AOP. FOR UV–CL2, DECARBONATOR TOWERS WOULD BE RELOCATED DOWNSTREAM OF UV REACTORS.

PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
◇1	13.4	9,300
◇2	12.3	8,600
◇3	1.07	700
◇4	10.5	7,300
◇5	1.85	1,300
◇6	10.5	7,300

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SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

GENERAL

SUNNYVALE 10.5 MGD
REGIONAL AWPF

PORTFOLIO 4B

PROCESS FLOW DIAGRAM

DRAWING NUMBER

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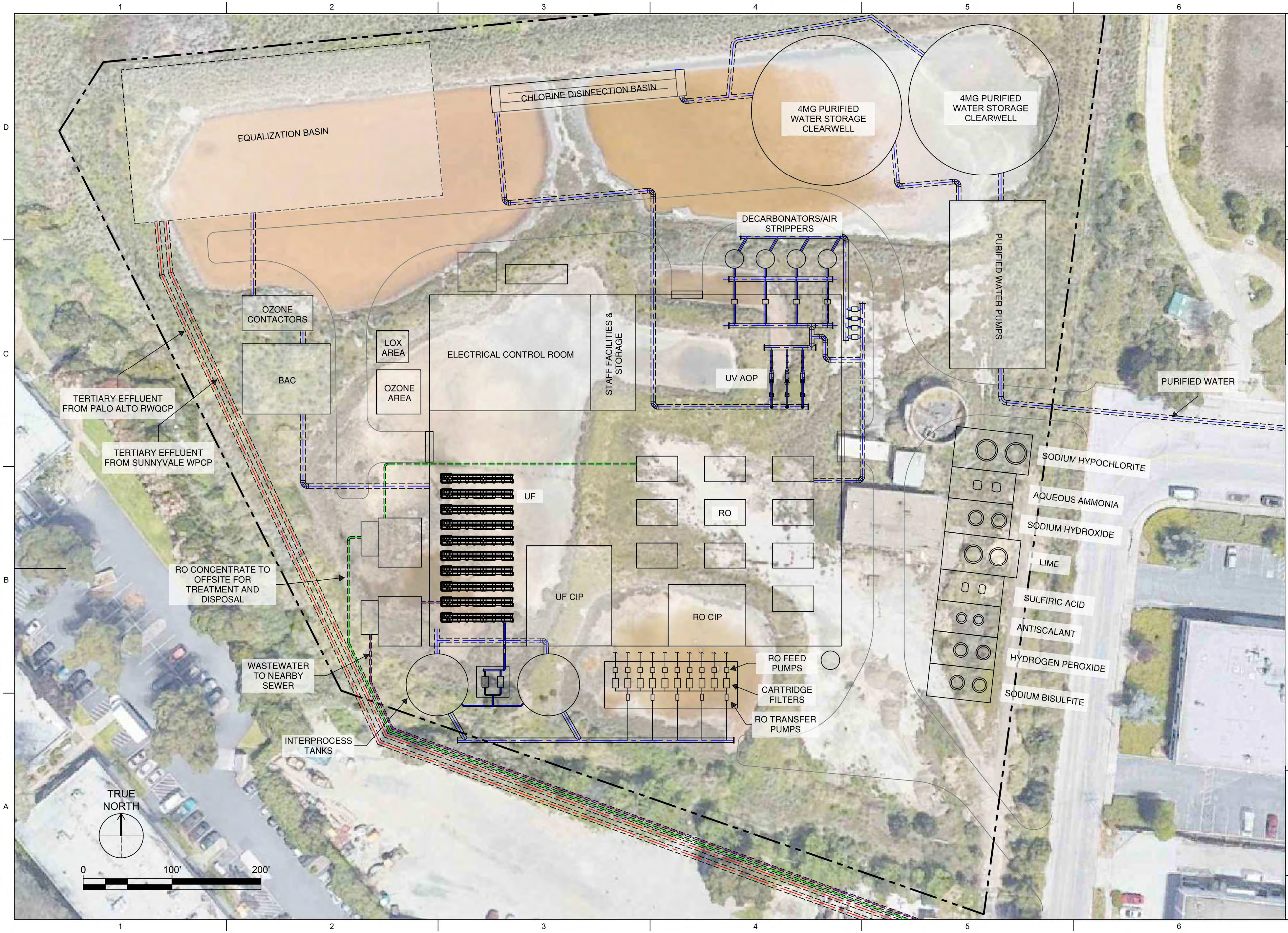

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SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

WESTSIDE TWA SCENARIO
WITH AWPF IN PALO ALTO

DRAWING NUMBER
15 OF 23

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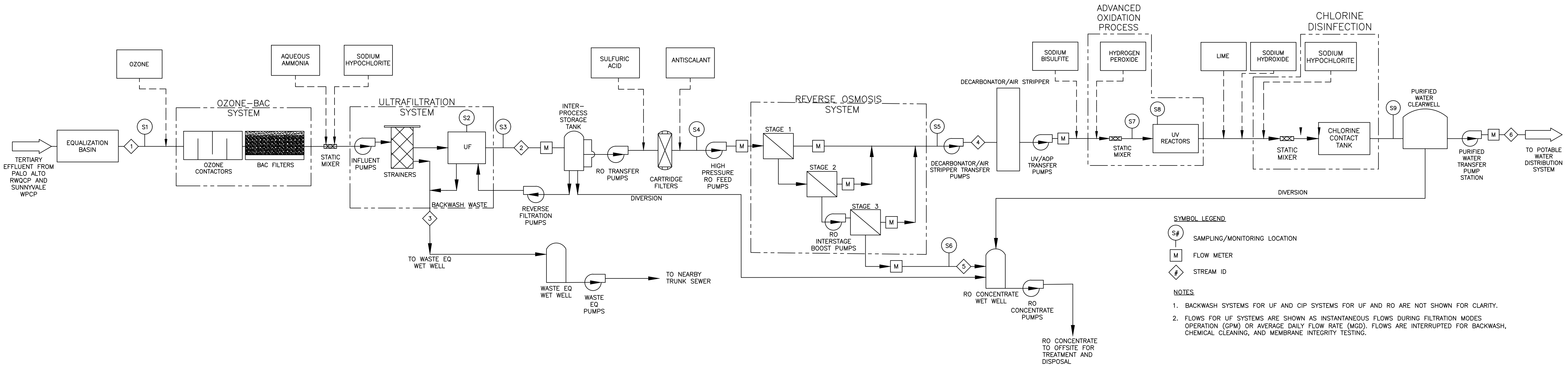

SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
#	STREAM ID

NOTES

1. BACKWASH SYSTEMS FOR UF AND CIP SYSTEMS FOR UF AND RO ARE NOT SHOWN FOR CLARITY.
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PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	31.3	21,700
2	28.8	20,000
3	2.5	1,700
4	24.5	17,000
5	4.3	3,000
6	24.5	17,000

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SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

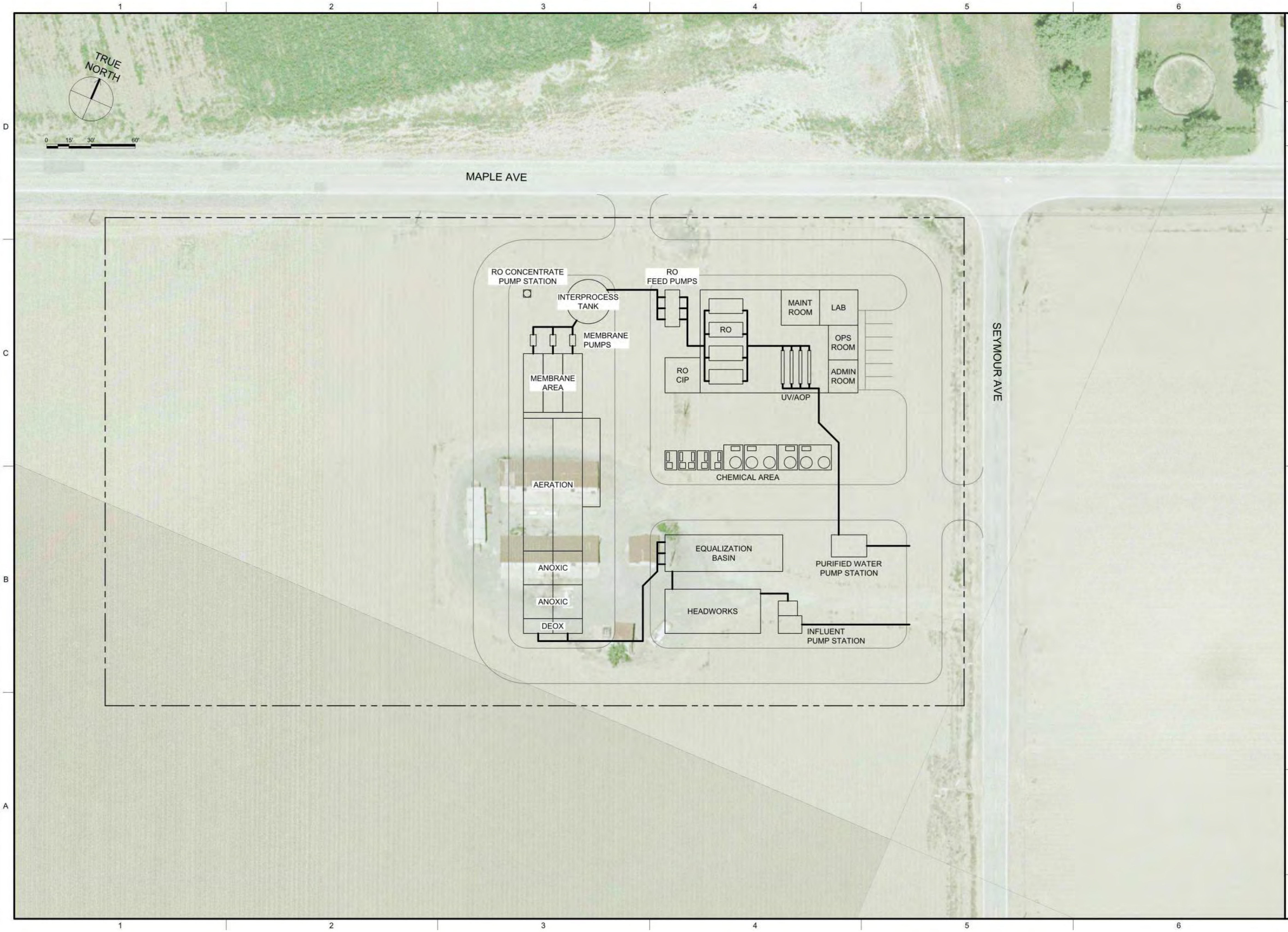
GENERAL

WESTSIDE TWA SCENARIO

PROCESS FLOW DIAGRAM

DRAWING NUMBER

16 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

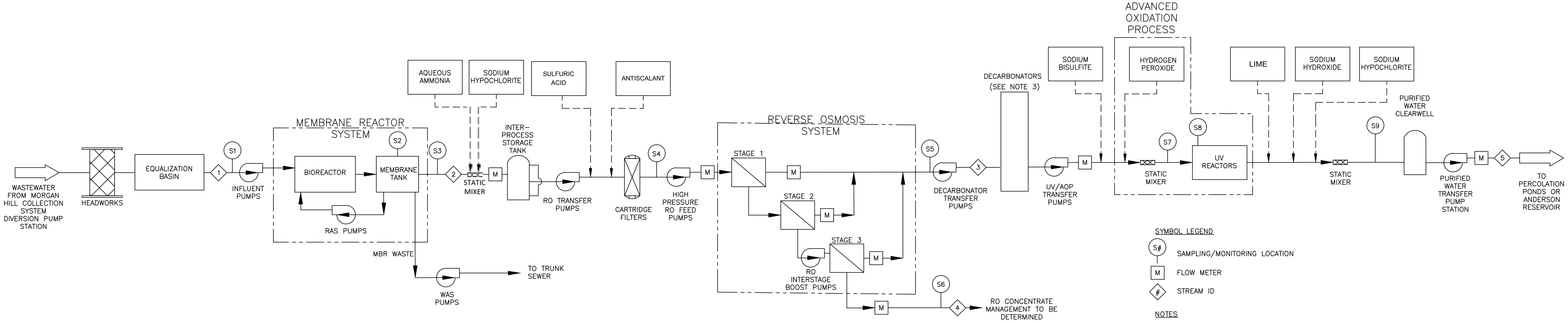
Valley Water

GENERAL

MORGAN HILL 2.5 MGD AWPF

DRAWING NUMBER

17 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇#	STREAM ID

NOTES

1. BACKWASH SYSTEMS FOR UF AND CIP SYSTEMS FOR UF AND RO ARE NOT SHOWN FOR CLARITY.
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3. FLOW CONFIGURED FOR UV–PEROXIDE AS AOP. FOR UV–CL2, DECARBONATOR TOWERS WOULD BE RELOCATED DOWNSTREAM OF UV REACTORS.

PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	2.5	1,700
2	2.5	1,700
3	2.1	1,500
4	0.38	300
5	2.1	1,500

Brown AND Caldwell

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

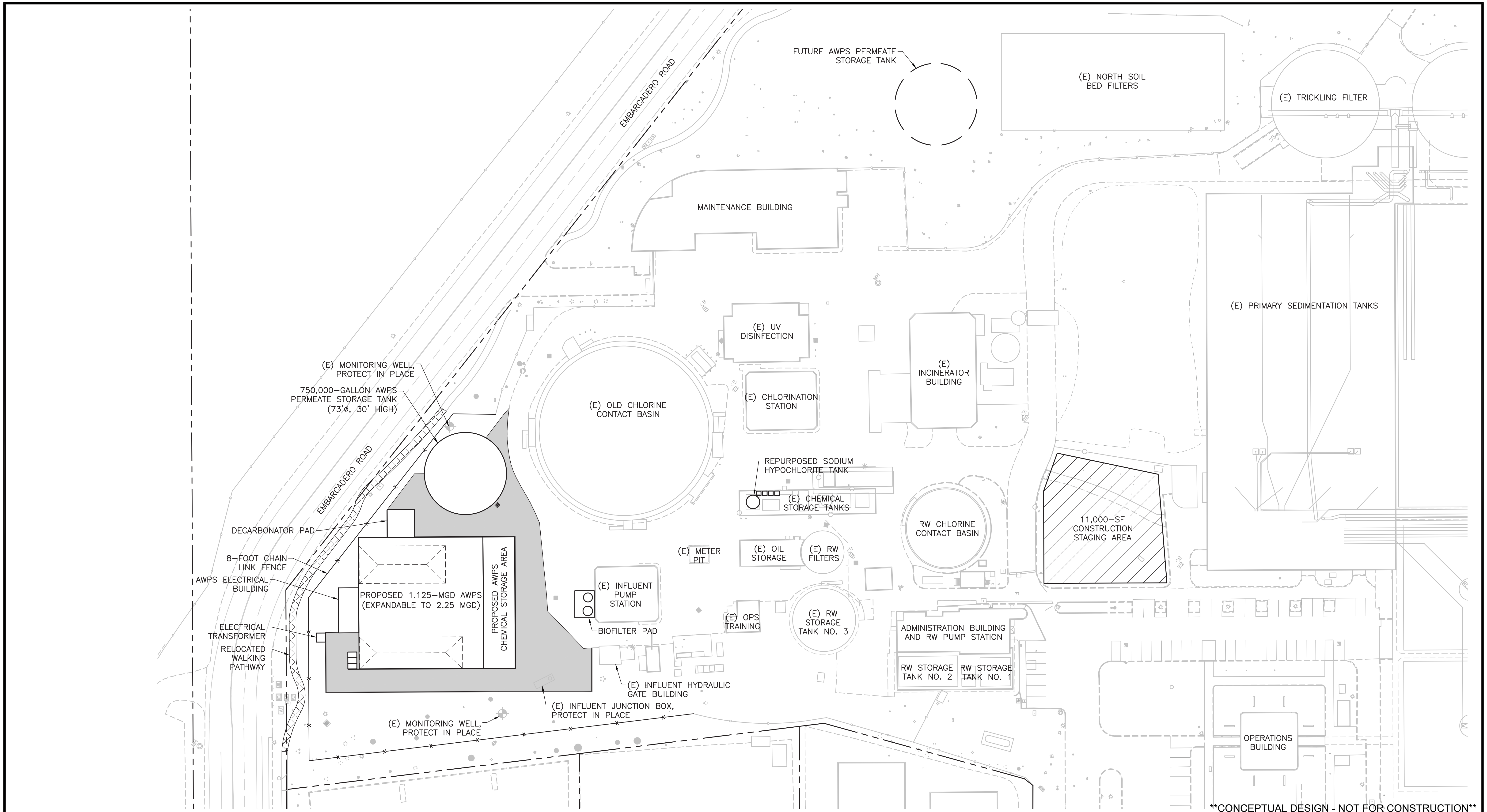
GENERAL

MORGAN HILL 2.5 MGD
AWPF

PROCESS FLOW DIAGRAM

DRAWING NUMBER

18 OF 23


FUTURE AWPS PERMEATE STORAGE TANK
(E) NORTH SOIL BED FILTERS
(E) TRICKLING FILTER
EMBARCADERO ROAD
MAINTENANCE BUILDING
(E) PRIMARY SEDIMENTATION TANKS
(E) UV DISINFECTION
(E) INCINERATOR BUILDING
(E) MONITORING WELL, PROTECT IN PLACE
750,000-GALLON AWPS PERMEATE STORAGE TANK (73'ø, 30' HIGH)
(E) OLD CHLORINE CONTACT BASIN
(E) CHLORINATION STATION
REPURPOSED SODIUM HYPOCHLORITE TANK
(E) CHEMICAL STORAGE TANKS
RW CHLORINE CONTACT BASIN
11,000-SF CONSTRUCTION STAGING AREA
EMBARCADERO ROAD
DECARBONATOR PAD
8-FOOT CHAIN LINK FENCE
AWPS ELECTRICAL BUILDING
(E) METER PIT
(E) OIL STORAGE
(E) RW FILTERS
PROPOSED 1.125-MGD AWPS (EXPANDABLE TO 2.25 MGD)
PROPOSED AWPS CHEMICAL STORAGE AREA
(E) INFLUENT PUMP STATION
(E) OPS TRAINING
(E) RW STORAGE TANK NO. 3
ADMINISTRATION BUILDING AND RW PUMP STATION
ELECTRICAL TRANSFORMER
BIOFILTER PAD
RELOCATED WALKING PATHWAY
RW STORAGE TANK NO. 2
RW STORAGE TANK NO. 1
(E) INFLUENT HYDRAULIC GATE BUILDING
(E) INFLUENT JUNCTION BOX, PROTECT IN PLACE
(E) MONITORING WELL, PROTECT IN PLACE
OPERATIONS BUILDING

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

LEGEND

— — —	PROPERTY LINE	—×—	PROPOSED CHAIN LINK FENCE
——	EXISTING RWQCP FACILITY	——	PROPOSED AWPS FACILITY
- - -	EXISTING EDGE OF PAVEMENT	▨	PROPOSED PAVEMENT
—○—	EXISTING FENCELINE	☒	RELOCATED WALKING PATHWAY
●	EXISTING TREE		

811

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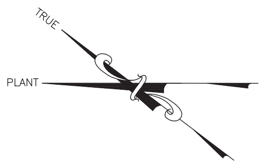


PROPERTY LINES ARE APPROXIMATE

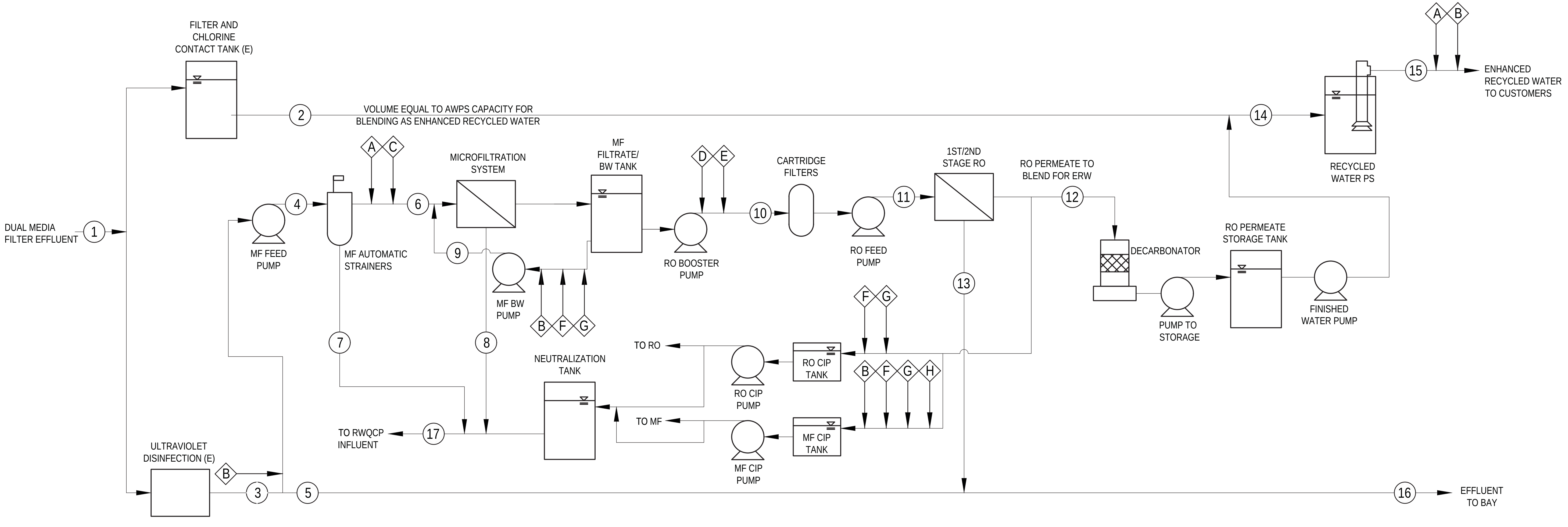
40' 20' 0' 20' 40'
1 inch = 40 ft.

MNS ENGINEERS INC
ENGINEERING | SURVEYING
CONSTRUCTION MANAGEMENT

111 N. Market Street
Suite 440
San Jose, CA 95113
408.610.4202 Phone

GHD

DESIGNED BY NEP					
DRAWN BY SPP	REV.	DATE	DESCRIPTION	BY	APP
CHECKED BY JA	SITE LAYOUT PLAN				PUBLIC WORKS DEPT. RWQCP SCALE: AS SHOWN
APPV'D BY	CITY OF PALO ALTO CALIFORNIA ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN				SHEET NO. C2



	DUAL MEDIA FILTER EFFLUENT	TERTIARY WATER FOR BLENDING AS ERW	RWQCP FINAL EFFLUENT TO BAY	FEED TO AWPS STRAINERS	REMAINING FINAL EFFLUENT FOR DISCHARGE TO BAY	MF FEED	STRAINERS BWW	MF BWW TO RWQCP INFLUENT	MF BACKWASH FLOW	RO LOW PRESSURE FEED	RO HIGH PRESSURE FEED	RO PERMEATE	RO CONCENTRATE	BLENDED ENHANCED RECYCLED WATER	ENHANCED RECYCLED WATER TO CUSTOMERS	FINAL EFFLUENT TO BAY	PROCESS WASTE TO HEADWORKS
PROCESS STREAM ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RECOVERY (%)						99.5%				93%		85%					
AVERAGE DESIGN FLOW (GPM)	14097	1563	12535	1986	10549	1976	NA	138	1573	1838	1838	1562	276	3125	3125	10825	138
AVERAGE DESIGN FLOW (MGD)	20.3	2.25	18.1	2.86	15.2	2.85	0.01	0.20	NA	2.65	2.65	2.25	0.40	4.50	4.50	15.59	0.20
PRESSURE (PSI)	<20	<20	<20	30–50	<20	30–45	ATM	ATM	30	30	125	10	15–30	<20	65–70	ATM	ATM

CHEMICAL	STREAM	PURPOSE
AQUEOUS AMMONIA	A	CHLORAMINE ADDITION
SODIUM HYPOCHLORITE	B	DISINFECTION/CHLORAMINES, MF MEMBRANE CLEANING
COAGULANT	C	MF PRETREATMENT
SULFURIC ACID	D	RO PRETREATMENT PH ADJUSTMENT
THRESHOLD INHIBITOR	E	RO ANTISCALANT
CITRIC ACID	F	MF/RO MEMBRANE CLEANING, MF BACKWASH
SODIUM HYDROXIDE	G	MF/RO MEMBRANE CLEANING, MF BACKWASH
SODIUM BISULFITE	H	MF CIP WASTE NEUTRALIZATION

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

NO SCALE

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San Jose, CA 95110
408.573.6421 Phone

GHD

DESIGNED BY	NEP
DRAWN BY	
CHECKED BY	JA
APPV'D BY	

REV.	DATE	DESCRIPTION	BY	APP

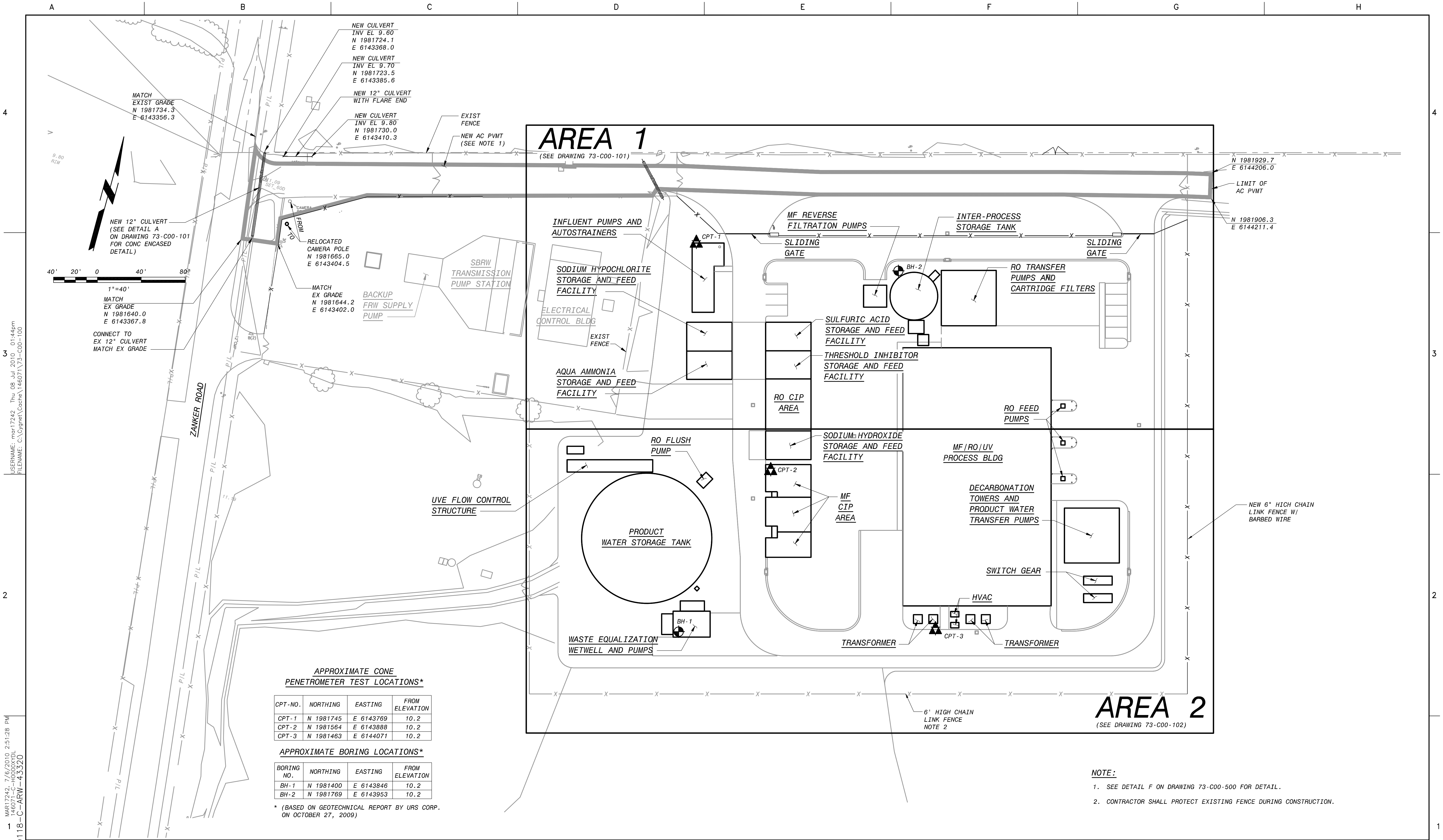
PROPOSED AWPS FACILITY
PROCESS FLOW DIAGRAM
2.25 MGD CAPACITY

CITY OF PALO ALTO
CALIFORNIA
ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

PUBLIC WORKS DEPT. RWQCP

SCALE: AS SHOWN

SHEET NO.
G2



APPROXIMATE CONE
PENETROMETER TEST LOCATIONS*

CPT-NO.	NORTHING	EASTING	FROM ELEVATION
CPT-1	N 1981745	E 6143769	10.2
CPT-2	N 1981564	E 6143888	10.2
CPT-3	N 1981463	E 6144071	10.2

APPROXIMATE BORING LOCATIONS*

BORING NO.	NORTHING	EASTING	FROM ELEVATION
BH-1	N 1981400	E 6143846	10.2
BH-2	N 1981769	E 6143953	10.2

* (BASED ON GEOTECHNICAL REPORT BY URS CORP.
ON OCTOBER 27, 2009)

NOTE:

1. SEE DETAIL F ON DRAWING 73-C00-500 FOR DETAIL.
2. CONTRACTOR SHALL PROTECT EXISTING FENCE DURING CONSTRUCTION.

REV	DESCRIPTION	DATE	APPR.
0	ISSUED FOR BID	07/10	SR

BLACK & VEATCH
Black & Veatch Corporation
Walnut Creek, California

DATE	07/02/10
DESIGN	DCL/BGP
DRAWN	BGP
CHECKED	RDR

ENGINEERING CERTIFICATION
DANIEL C. LOPEZ
No. C 054330
Exp. 12/31/11
CIVIL
07/02/10

SOUTH BAY
WATER RECYCLING
CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:
SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITY
CIVIL
SITE LAYOUT

SCALE
1"=40'
VERIFY SCALES
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PROJECT NUMBER
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SHEET CODE:
B&V 73-C00-100
CITY
DISTRICT
15 OF 261

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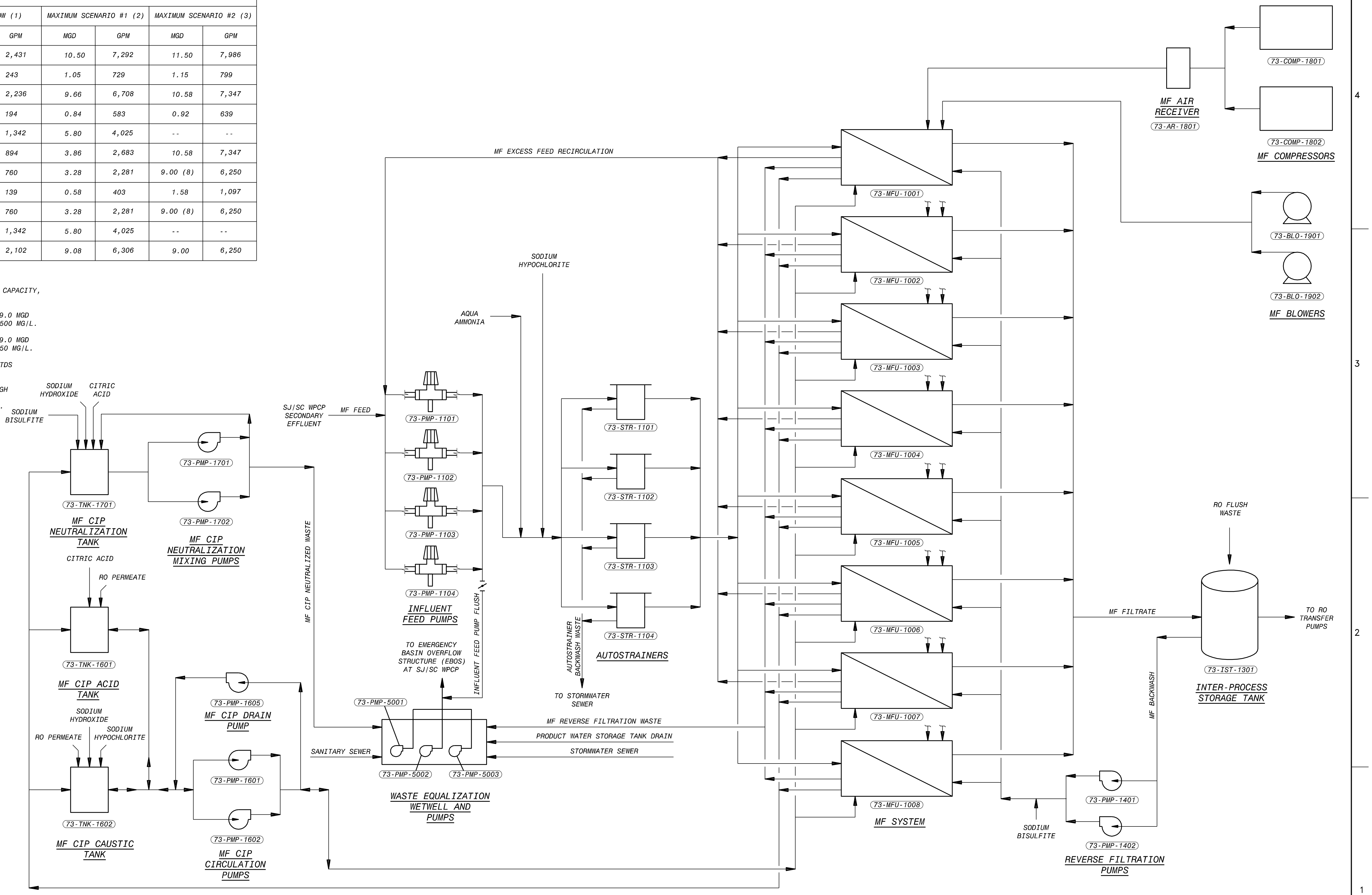
PROCESS DESIGN FLOWS

	MINIMUM FLOW (1)		MAXIMUM SCENARIO #1 (2)		MAXIMUM SCENARIO #2 (3)	
STREAM NAME	MGD	GPM	MGD	GPM	MGD	GPM
MF FEED WATER (4)	3.50	2,431	10.50	7,292	11.50	7,986
MF EXCESS FEED RECIRCULATION (7)	0.35	243	1.05	729	1.15	799
MF FILTRATE (5)	3.22	2,236	9.66	6,708	10.58	7,347
MF BACKWASH	0.28	194	0.84	583	0.92	639
RO BYPASS	1.93	1,342	5.80	4,025	--	--
RO FEED	1.29	894	3.86	2,683	10.58	7,347
RO PERMEATE (6)	1.09	760	3.28	2,281	9.00 (8)	6,250
RO CONCENTRATE	0.20	139	0.58	403	1.58	1,097
UV FEED (RO PERMEATE)	1.09	760	3.28	2,281	9.00 (8)	6,250
UV FEED (RO BYPASS)	1.93	1,342	5.80	4,025	--	--
FINAL TREATED EFFLUENT	3.03	2,102	9.08	6,306	9.00	6,250

NOTES

1. THE MINIMUM FLOW IS BASED ON A 3.0 MGD ARWTF CAPACITY, WITH A PRODUCT WATER TDS OF 500 MG/L.
2. THE MAXIMUM FLOW, SCENARIO #1 IS BASED ON A 9.0 MGD ARWTF CAPACITY, WITH A PRODUCT WATER TDS OF 500 MG/L.
3. THE MAXIMUM FLOW, SCENARIO #2 IS BASED ON A 9.0 MGD ARWTF CAPACITY, WITH A PRODUCT WATER TDS OF 50 MG/L. THIS SCENARIO ASSUMES BLENDING WITH TERTIARY EFFLUENT FROM THE WPCP TO ACHIEVE A BLENDED TDS OF 500 MG/L.
4. ASSUMES NO EXCESS FEED RECIRCULATION, ALTHOUGH PROVISIONS WILL BE PROVIDED IN THE EVENT THIS IS NEEDED BY THE MF SYSTEM.
5. ASSUMES MF RECOVERY OF 92 PERCENT.
6. ASSUMES RO RECOVERY OF 85 PERCENT.
7. APPROXIMATELY 10 PERCENT OF THE MF FEED WATER WILL BE RECIRCULATED TO THE SUCTION OF THE INFLUENT FEED PUMPS.
8. THE INITIAL RO SYSTEM DESIGN IS BASE ON A PRODUCTION OF 8.0 MGD. THE RO SYSTEM IS EXPANDABLE TO 9.0 MGD.



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BLACK & VEATCH
Black & Veatch Corporation
Walnut Creek, California

DATE 07/02/10
DESIGN DCL
DRAWN JMM
CHECKED RDR

ENGINEERING CERTIFICATION
DANIEL C. LOPEZ
No. C 054330
Exp. 12/31/11
CIVIL
07/02/10

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL SILICON V LLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITY

GENERAL
PROCESS FLOW DIAGRAM (SHEET 1 OF 2)

SCALE
NONE
VERIFY SCALES
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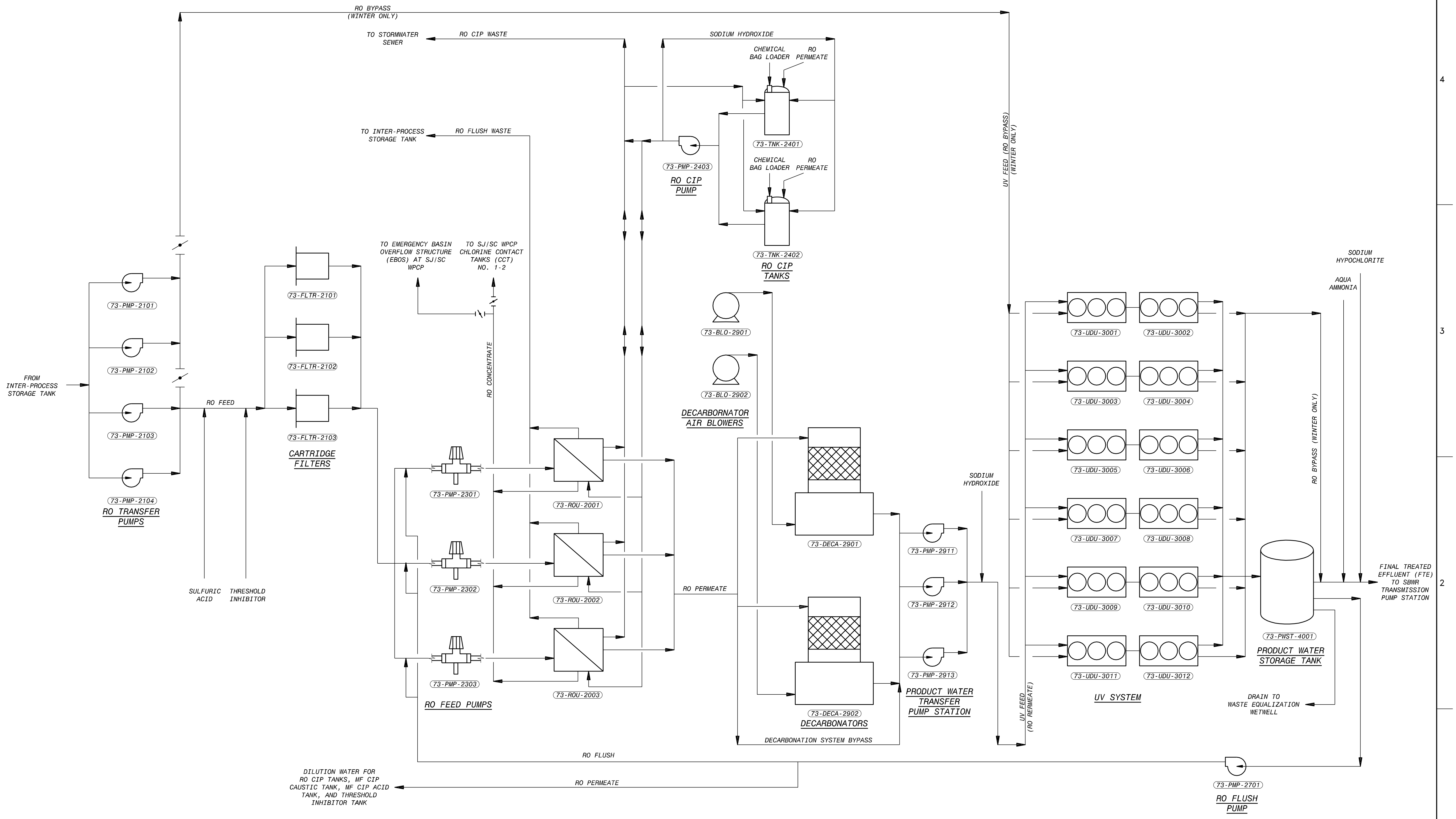
PROJECT NUMBER
91184008
SHEET CODE:
B&V 73-G00-007
CITY
DISTRICT
8 OF 261



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BLACK & VEATCH
Black & Veatch Corporation
Walnut Creek, California

DATE	07/02/10
DESIGN	MNT
DRAWN	JMM
CHECKED	RDR

ENGINEERING CERTIFICATION
No. C 054330
Exp. 12/31/11
DANIEL C. LOPEZ
07/02/10

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITY
GENERAL
PROCESS FLOW DIAGRAM (SHEET 2 OF 2)

SCALE
NONE

VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER
91184008

SHEET CODE:
B&V 73-G00-008
CITY
DISTRICT
9 OF 261

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Appendix A-5: Basis of Cost

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1.1 Introduction

This Basis of Cost summary documents the approach and factors used to develop the estimated capital and operations and maintenance (O&M) costs for the Santa Clara Valley Water District's (Valley Water) *Countywide Water Reuse Master Plan* (Master Plan). The basis of cost documents the capital, O&M, replacement and renewal (R&R), and life-cycle costs to evaluate and compare project elements and portfolios. It does not attribute costs or benefits to payers and beneficiaries.

1.1.1 Previous Work

Valley Water and the Partner Agencies have developed many relevant studies and plans that are now serving as a foundation for the Master Plan. While the past studies are invaluable in many respects, the basis of costs often varies between projects as a function of scope, cost estimating approach, level of detail, and available cost data. Cost estimates should provide a common basis to enable meaningful comparisons among alternatives or portfolios.

In 2018, Valley Water completed the *Expedited Purified Water Program Plan* (Program Plan), which developed and evaluated a range of potable reuse options. The Program Plan involved developing preliminary designs and cost estimates of potential advanced water purification facilities (AWPF) and conveyance facilities, including some that are still being explored under the Master Plan, such as a 24 million gallons per day (mgd) AWPF at San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF), infrastructure improvements at Los Gatos Recharge Ponds (LGRP) for groundwater recharge (GWR), and a connection to Penitencia Water Treatment Plant (WTP) for raw water augmentation (RWA). To support comparison of costs and an economic assessment, the Master Plan uses an approach consistent with the 2017 *Program Plan Basis of Cost Estimating* memorandum for estimating costs of potable reuse elements.

For non-potable reuse (NPR), the approach for cost estimating relies on the Partner Agencies' recycled water master plans, which describe plans for NPR distribution system expansions and provide associated cost estimates. Costs from existing plans were escalated to current value based on Engineering News-Record (ENR) Construction Cost Index (CCI).

1.1.2 Class of Estimate

The cost estimates align with the Association for the Advancement of Cost Engineering (AACE) International's criteria for Class 5 estimates, except for cost estimates for AWPFs, which align with Class 4. Expected accuracy for Class 5 estimates typically ranges from -50 percent to +100 percent, while expected accuracy for Class 4 estimates typically ranges from -30 to +50 percent.

1.1.3 Cost Development

BC prepared the cost estimates using a Windows-based commercial estimating software engine, BC's material and labor database, historical project data, current vendor and material cost information, and other cost benchmarks specific to the project locale. The estimates reflect capital costs (i.e., construction, equipment, contractor, and relevant markups), as well as O&M and R&R costs. Labor rates reflect burdens such as salary and benefits. Trade discounts were not considered.

As is customary practice in a planning-level design, reference documents and available information lacked some details, resulting in the estimator's use of the following assumptions:

1. Equipment rental rates are based on verifiable pricing from the local project area rental yards, Blue Book rates, and/or rates contained in BC's estimating database.
2. Contractor markup is based on conventionally accepted values and adjusted for project-area economic factors.

3. Major equipment costs are based on Silicon Valley Advanced Water Purification Center (SVAWPC) facility costs and vendor-supplied price quotes obtained by BC engineers.
4. Bulk material quantities are based on manual quantity take-offs.
5. Sufficient electrical power is available to feed equipment specified in the preliminary designs. The local power company will supply power and transformers suitable for the potential facilities. (Note: If eligible for Power and Water Resources Pooling Authority [PWRPA] rates, there is potential for lower power costs. The use of PWRPA should be considered during the design phase when location and size of the improvements are further defined.)
6. Soils are of adequate nature to support the structures.

1.1.4 Construction Cost Divisions

The Construction Specifications Institute's MasterFormat provides construction divisions, the most widely used standard for organizing written information for commercial and institutional building projects in the U.S. and Canada. The original format is based on 16 divisions. In 2004, MasterFormat was updated and expanded to 50 divisions.

The Master Plan's detailed cost estimates are presented in the current 50-division system and in the original 16-division system (when adopting the structure of cost estimates from the 2017 Program Plan). Each asset was assigned a specification division (e.g., general, sitework, concrete) and quantity that were used to structure estimated costs obtained from manufacturers, past projects, and/or industry resources. Table 1-1 presents a list of general assumptions by division.

Table 1-1. Construction Cost Divisions and Assumptions

Division	Division (2017 Program Plan)	Assumptions
01 – General requirements	01 - General Requirements	• General requirements of 10% design account for mobilization/demobilization, supervision, temporary utilities and facilities.
03 - Concrete	03 - Concrete	• All concrete is included as 5,000 pounds per square inch (psi) and 4,000 psi for equipment pad. • Concrete slab on grade, walls, and suspended slab reinforcing steel is included at 200 pounds per cubic yard (lb/yd^3) for all structures. Equipment pads reinforcing steel is included at 150 lb/yd^3 for all structures. • Epoxy-coated rebar is not included for any structures.
05 - Metals	05 - Metals	• A lump-sum allowance for metals is included.
09 - Finishes	09 - Finishes	• A lump-sum allowance for painting and coatings is included.
17 - Instrumentation	17 - Instrumentation	• An allowance of 25% of electrical costs is included.
26 – Electrical	16 – Electrical	• Electrical distribution costs are based on the pumps and motors listed in flow diagrams and piping and instrumentation diagrams. • An allowance for new electrical service is included. • An allowance of 30% of equipment costs is included.
31 - Earthwork	02 - Sitework	• Structural excavation and backfill costs are based on professional judgment regarding structure depths. The excavation cost reflects soil excavation. • Includes pipelines, casing, sheeting and shoring, and potholing. • An allowance is included for landscaping, lighting and security, and site dewatering. • Subgrade structural piles are included for AWPF facilities at Palo Alto, Sunnyvale, and San José sites.
32 - Exterior improvements	05 - Metals	• Chain link fence around the facility is included.

Table 1-1. Construction Cost Divisions and Assumptions

Division	Division (2017 Program Plan)	Assumptions
40 – Process integration	15 - Mechanical	• An allowance of 30% of equipment costs is included. • An allowance of 5% of piping costs is included for valves, fitting, and supports.
43 - Process gas and liquid handling, purification, and storage	10 – Specialties	• Process building based on per-square-foot unit cost is included. • Chemical storage and tank costs are included.
46 – Water and wastewater equipment	11 – Equipment	• Equipment costs include ultraviolet (UV) treatment, reverse osmosis (RO), decarbonator, UV system, pumps, and tanks.

1.2 Project Elements

This section introduces the costing methods and assumptions for the Master Plan’s project elements and principal cost components:

- AWPFs
- Pump stations
- Conveyance pipelines
- NPR distribution system expansion
- Delivery point improvements (i.e., Los Gatos Recharge Ponds and Penitencia WTP improvements)

1.2.1 Advanced Water Purification Facilities

AWPFs represent a substantial portion of purified water program costs. The cost of the facilities depends on the quality of source water, type and quantity of purified water, regulatory requirements, process design, site characteristics, and facility characteristics. Facilities planning included development of preliminary process design, design criteria, and site layouts that form the basis for estimating quantities and cost. The proposed AWPFs follow a similar approach used for the existing SVAWPC with modifications based on needs identified by Valley Water.

The following are major assumptions for AWPF estimates:

- AWPFs are considered non-essential facilities and not equipped with standby power or process equipment redundancy for ultrafiltration (UF), RO, or decarbonation processes
- Full advanced treatment required
- Membrane and UV equipment located indoors
- Decarbonator towers, chemical facilities, and pump stations located outdoors
- Certified laboratory facilities excluded but includes a sample preparation area
- Where foundation piles were used for the existing SVAWPC facilities, adjacent proposed AWPF assumed a similar approach for pile supports.
- Facilities sited at “Recycle Hill” in Sunnyvale would require site preparation to remove landfill materials. Costs for excavation, trucking, disposal, and fill were estimated by the City of Sunnyvale in 2016 at between $30 million and $38 million. For this estimate, these costs were rounded to $40 million and escalated to $43.5 million in 2019 dollars based on ENR CCI.

1.2.1.1 Equipment

Process and ancillary equipment and installation represent a substantial portion of the raw construction cost for AWPFs. Costs for equipment are based on two sources: scaled SVAWPC costs; and equipment vendor budget proposals customized to influent water quality, desired effluent water quality, and facility plans. Equipment installation costs are estimated as a percentage of equipment costs from vendor proposals and were estimated at 50 percent for process equipment, such as microfiltration, RO, and UV.

1.2.1.2 Mobilization/Demobilization

Mobilization involves the process of establishing resources at a project site that are to be used over the course of the project, such as temporary office trailers, temporary utilities, and other equipment rental. Mobilization also includes insurance, bonding, administrative submittals, and regulatory permitting like stormwater pollution prevention plans. Demobilization involves removing temporary facilities, trailer(s), and the final move off the construction site. For this project, mobilization/demobilization is estimated as 10 percent of the sum of raw construction cost and categorized under Division 1 – General.

1.2.1.3 Site Work

Site work includes work related to the civil construction of facilities. The associated costs for the major elements are based on unit costs from RSMeans and quantity estimates based on facility drawings and construction assumptions.

Table 1-2 presents assumptions for site work used to determine AWPF cost estimates.

Table 1-2. Site Work Assumptions for AWPFs

Item	Value	Measurement	Unit
Slab	2	Depth	ft
Wall	1.5	Width	ft
Chemical Wall	8	Width	in.
Chemical Wall	56	Depth	in.
Paved – Asphalt	4	Depth	in.
Paved - Ag Base	12	Depth	in.
Paved – Backfill	0	Depth	in. (already 3' of backfill to raise site)
Unpaved – Gravel	4	Depth	in.
Unpaved - Ag Base	12	Depth	in.
Unpaved – Backfill	0	Depth	in. (already 3' of backfill to raise site)
Slab on Grade - Ag Base	12	Depth	in.
Depth of Compaction	1.5	Depth	ft

1.2.1.4 Property and Easements

The AWPF cost estimations do not assume the purchase of private property.

1.2.1.5 Concrete

Table 1-3 presents assumptions for concrete unit costs used to determine AWPF cost estimates.

Table 1-3. Concrete Unit Costs

Concrete Setting	Installed Unit Cost ($/CY)	Source
Slab on grade	$800	Sage Accounting, 2019
Suspended slab	$1,500	Sage Accounting, 2019
Wall (cast in place)	$1,000	Sage Accounting, 2019

1.2.1.6 Buildings

Membrane and UV process equipment for the AWPFs are assumed to be enclosed in pre-engineered buildings similar to the SVAWPC. Building costs include HVAC and fire suppression for structures. Additional building space is necessary for O&M staff, storage, sample preparation, and other support functions. Process building costs are based on SVAWPC costs.

1.2.1.7 Chemical Facilities

Chemical facilities include storage tanks and totes, chemical metering pumps, canopies, and spill containment. Chemical storage quantities are determined as described in the specific facilities plans, then the appropriate storage container and number of metering pumps are selected based on the quantity and specific chemical properties. Costs for storage tanks and totes and metering pumps were obtained from vendor quotes and RSMeans estimates.

1.2.1.8 Piping, Fitting, and Valves

The AWPF includes both yard and mechanical process piping. All facility piping was estimated based on engineering judgment. Allowance for piping is 30 percent of equipment costs. Allowance for fittings and valves were each estimated as 5 percent of the piping allowance. The cost estimate for conveyance pipelines are presented separately from the AWPF costs.

1.2.1.9 Electrical and Instrumentation

Space allocations were incorporated into the AWPF building for an electrical room and operations room; however, electrical and instrumentation-specific details (i.e., electrical service, duct banks, motor control center, instrument monitoring, SCADA, etc.) have not been defined at this facility-planning level. Therefore, allowances are used as a basis for electrical and instrumentation cost estimates. Electrical cost allowance was estimated as 30 percent of the total Division 46 – Water and Wastewater Equipment cost. Instrumentation cost was estimated as 25 percent of the total Division 26 – Electrical cost. Full electrical redundancy for the treatment facilities is not required as the facility is considered non-essential.

1.2.2 Pump Stations

Pump station costs vary depending on hydraulic requirements, type of pumps, pump station arrangement, surge control systems, and other project characteristics. Pump power assumes 65 percent efficiency and a 10 percent safety factor. Cost estimates are based on the Expedited Purified Water Program.

Table 1-4 presents attributes and estimated capital costs of pump stations considered in the plan.

Table 1-4. Attributes of Pump Stations for Potable Reuse

Portfolio/ Option	Pump Station Number	Treatment Level of Water to be Pumped	Start Point	End Point	Flow (gpm)	Total Dynamic Head (ft)	Pump Power (hp)
1a	PS-1	Purified water	San José AWPF	LGRP	16,667	400	2,877
1b	PS-2	Purified water	San José AWPF	Penitencia WTP	16,667	550	3,977
1c	PS-14	Purified water	San José AWPF	Water modulating valve vault at Penitencia WTP	16,667	350	2,500
1c	PS-15	Purified water	San José AWPF	Northside Santa Clara	8,333	250	890
1d	PS-16	Purified water	San José AWPF	Water modulating valve vault at Penitencia WTP	16,667	350	2,500
1d	PS-17	Purified water	San José AWPF	Northside Santa Clara	8,333	250	890
2a	PS-3	Effluent	Palo Alto RWQCP	Palo Alto AWPF	12,000	100	508
2a	PS-4	Effluent	Sunnyvale WPCP	Palo Alto AWPF	8,000	100	400
2a	PS-5	Purified water	Palo Alto AWPF	LGRP	16,667	400	2,877
2b	PS-6	Effluent	Palo Alto RWQCP	Sunnyvale AWPF	12,000	100	508
2b	PS-7	Purified water	Sunnyvale AWPF	LGRP	16,667	400	2,877
4	PS-3	Effluent	Palo Alto RWQCP	Palo Alto AWPF	12,000	100	508
4	PS-9	Purified water	Palo Alto AWPF	LGRP	9,722	400	1,650
4	PS-10	Purified water	Sunnyvale AWPF	LGRP	6,945	400	1,400
West County TWA	PS-3	Effluent	Palo Alto RWQCP	Palo Alto AWPF	12,000	100	508
West County TWA	PS-4	Effluent	Sunnyvale WPCP	Palo Alto AWPF	8,000	100	400
West County TWA	PS-18	Purified water	Palo Alto AWPF	West Pipeline at Stevens Creek	16,667	500	3,570
Morgan Hill[a]							
Option 2	PS-13	Purified water	Morgan Hill Satellite AWPF	San Pedro Ponds	1,458	125	78
Option 3	PS-11	Purified water	Morgan Hill Satellite AWPF	Booster Pump Station	1,458	500	279
Option 3	PS-12	Purified water	Booster Pump Station	Anderson Reservoir	1,458	350	218

a. Portfolios do not include costs for Morgan Hill recycled water alternatives

hp = horsepower

TWA = Treated Water Augmentation

1.2.3 Conveyance Pipelines

Conveyance includes both purified water and effluent pipelines that feed water into the AWPF. Conveyance estimates are based on costs from the Expedited Purified Water Program and experience implementing projects locally in urban settings with more than 12 feet of cover. The estimate reflects costs for cement-lined ductile iron pipe.

The capital costs for each pipeline include an estimated cost for easements. Easement costs are calculated using an extrapolated unit cost of $32 per linear foot, based on the easement cost estimate of $3 million for Component 1 in the Expedited Purified Water Program. This cost was applied to all pipelines except those included in Portfolio 1b, 1c, and 1d, which used a unit cost of $222 per linear foot based on Component 2 in the Expedited Purified Water Program.

Table 1-5 presents conveyance unit cost estimates.

Table 1-5. Conveyance Unit Cost Estimates Rate (%)

Item	Rate
Open cut unit cost total (all inclusive)	**$23.20/in-ft**
Raw installed cost	$20/in-ft
Traffic control	7%
Sheeting and Shoring	7%
Potholing	2%
Bore and jack unit cost total (all inclusive)	**$52/in-ft**
Casing (including launching and receiving pits)	$32/in-ft
Carrier Pipe	$20/in-ft
Microtunneling unit cost total (all inclusive)	**$70/in-ft**
Casing (including launching and receiving pits)	$50/in-ft
Carrier Pipe	$20/in-ft
Horizontal directional drilling (no casing) Unit Cost	**$28/in-ft**
Horsepower unit cost	**$4,000/hp**
Horsepower efficiency	65%
Safety Factor	10%
Easements	-
Pipelines except Portfolios 1b, 1c, and 1d	$32/ft
Pipelines in Portfolio 1b, 1c, and 1d	$222/ft

in-ft = inch diameter, feet of pipe

1.3 Capital Costs

Capital costs consist of:

- Raw construction costs for new treatment and conveyance facilities and expansion of existing NPR distribution systems.
- Markups, including contractor overhead and profit, sales tax, equipment installation cost, and contingency.

- Implementation costs, including change orders, engineering services for design and construction, and construction management (CM). Legal and administrative costs associated with implementation also are incorporated.

The capital cost estimate assumes a design-bid-build implementation approach. Appendix A-6 presents detailed cost estimates, including capital costs for each portfolio.

1.3.1 Raw Construction Costs

Capital cost estimates rely on estimated construction costs and unit costs developed using RSMeans, vendor quotes, and equipment pricing furnished by either an engineering team or an estimator. The estimate includes equipment and construction-related labor costs and anticipated productivity adjustments to labor. Based on the level of detail available, percentage-based allowances are used for some elements, such as electrical and instrumentation. See Exhibit 1 for a list of unit costs for construction and O&M.

Construction cost factors were used to develop and escalate unit costs when required to reflect the current bid environment, industry trends, and project location. Two factors are incorporated into some of the unit costs:

- **ENR CCI** – Since the rate of construction cost inflation varies by geographic region, the ENR CCI converts historic cost information to current dollar values. The ENR CCI for San Francisco (SF) is applied to adjust unit cost and other cost estimates established at a different point in time to a common cost basis. All Countywide Master Plan estimated construction costs are indexed to an August 2019 ENR CCI SF of 12,368.21.
- **RSMeans Location Factor** – The unit costs presented in RSMeans represent the national average across the United States and Canada. A location factor, also referred to as a city cost index, is applied to account for variations in regional costs such as labor, equipment rental, raw materials, and freight. It represents a weighted average of both materials and labor costs across all divisions of construction. Where national average costs are used from resources such as RSMeans, a location factor of 123.5 percent was applied for the City of San José to account for local cost conditions.

Preliminary design criteria and facility layouts provided the basis for estimating AWPF construction costs. BC collected proposals from equipment manufacturers for treatment process systems such as UF, RO, membrane bioreactor (MBR), and UV. Other resources tapped for AWPF estimates included unit costs from past construction projects and industry estimating resources, such as RSMeans 2019. If cost data were not available, an estimate was made based on engineering judgment and best information available.

1.3.2 Contractor and Other Markups

Markups are conventionally accepted values and adjusted for the local economy. The following factors apply to facilities estimates:

- **Contingency** – Contingency is incorporated to provide flexibility to address costs related to unforeseen future and circumstances that are possible but cannot be predicted with certainty, such as fluctuations in the economy. Based on industry standard, the level of project definition and complexity, and local factors, construction contingency can range from 10 to 50 percent. This estimate incorporates a 25 percent contingency, selected using engineering judgment.
- **Contractor Overhead and Profit** – Contractor overhead and profit costs consist of standard expenses for a business to remain operational, including staff resources (e.g., salaries, fringe time, benefits), outsourced labor (e.g., accountant, legal, information technology), office costs, tools, equipment/vehicles, training, and insurance. A factor of 15 percent is used based on engineering judgment and past experiences. Overhead and profit is not applied to consumable (e.g., UF/RO replacement membranes or chemicals).

- **Sales Tax** – Sales tax applies to half the subtotal of construction costs and contingency and reflects current local sales rates (as of October 2019).
- **Equipment Installation** – Equipment installation costs consist of relevant labor, equipment delivery, sizing, foundation, and material costs associated with making equipment fully functional. Based on engineering judgment and past experiences, a 50 percent markup on total equipment cost is used as an estimate.

Table 1-6 presents percentage factors based on raw construction costs and contingency.

Table 1-6. Contractor and Other Markups

Item	Rate (%)	Applied to
Contingency	25%	Raw construction costs
Contractor's markups		Sum of raw construction costs and contingency
Contractor overhead and profit	15%	
Contractor overhead and Profit – UF/RO/Chemicals Only	0%	
Other markups		
Sales tax on materials (applied to half the construction cost subtotal)	9%	
Equipment installation cost (for AWPFs only)	50%	

1.3.3 Implementation Costs

Implementation costs are estimated as a percentage of the total construction cost (including contingency, tax, and general contractor overhead and profit). Implementation costs support change orders, engineering design, construction services, and CM. The following factors apply to facilities estimates:

- **Owner's Reserve for Change Orders** – Change orders may be a result of the Owner's direction to implement additional work, differing field conditions that require additional work, or an error in the project contract documents.
- **Engineering Services** – Engineering services include field investigations, such as surveys, geotechnical reports, and hazard materials investigations, preliminary and final design, contract document development, preparation of detailed cost estimations, and project scheduling.
- **Construction Management** – CM includes planning, coordinating, and providing monitoring and controlling of a construction project.
- **Engineering Services During Construction** – Engineering services during construction typically include submittal and request for information reviews, design clarifications, and startup support services.

Table 1-7 summarizes the implementation cost factors from the *Expedited Purified Water Program Plan* that have been adopted for this estimate. Legal and administration costs are not included as a separate percentage but are accounted for in each of the percentages. Since Valley Water has already retained a consultant for environmental review services, the related cost will not apply to individual project elements. Rather, the cost for environmental review is applied to the overall program cost.

Table 1-7. Implementation Cost Factors

Element	Percentage[a]	Notes
Owner's reserve for change orders	15%	
Engineering services (design)	15%	
Construction management	13%	
Engineering services (construction)	12%	

a. Legal and administrative costs for the project are incorporated into the percentage for each element. Environmental review services are not included in the estimate.

1.4 Operations and Maintenance Costs

Appendix A-6 presents detailed cost estimates, including O&M costs for each portfolio.

1.4.1 O&M Cost Components

O&M costs are based on estimated labor hours, equipment power and energy needs, chemicals, and other consumable demands. Specific information on unit costs and sources for each element is contained in the unit cost spreadsheet in Exhibit 1 of this document.

1.4.1.1 Labor

Table 1-8 summarizes labor unit cost factors based on data received from Valley Water Operations Unit in July 2019. The labor rates are fully loaded and cover base salary, benefits, and employer-paid taxes.

Table 1-8. Labor Costs

Plant	Cost	SVAPWC Assumptions
Water plant operator	$163.20/hour	3 operators at the plant; by average each has 1,654 hours/year
Senior mechanics	$172.27/hour	1,460 hours/year
Control tech II	$172.27/hour	1,818 hours/year
Supervisor	$166.58/hour	1,759 hours/year

Each AWPF facility uses a customized labor estimate based on engineering judgment and individual facility needs.

1.4.1.2 Electricity

Table 1-9 summarizes assumptions used for electricity rates at potential facilities.

Table 1-9. Power/Energy Rates at Potential Facilities

City	Utility	Unit	Cost[a]	Assumptions
Sunnyvale and San José	PG&E	per kilowatt hour	$0.16	Baseline Industrial "average" cost for July 1, 2019-Present. Rate schedule: E20 Primary Firm
Palo Alto	Palo Alto	per kilowatt hour	$0.19	Average of energy charge for large non-residential electric service summer and winter period effective July 1, 2019. Rate schedule: Utility Rate Schedule E-7

a. If eligible for PWRPA rates, there is potential for power cost savings. The use of PWRPA should be considered during the design phase when location and size of the improvements are further defined.

1.4.1.3 Chemicals

Table 1-10 summarizes chemical unit cost estimates.

Table 1-10. Chemical Costs

Unit Cost	Value	Unit	Source
Liquid oxygen	$0.04	$/lb	Donald C. Tillman Water Reclamation Plant Estimate
Lime	$0.15	$/lb	Donald C. Tillman Water Reclamation Plant Estimate
Sodium hypochlorite	$0.61	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Oxalic acid	$0.71	$/lb	From Yuba City, Alameda County Water District-Union Sanitary District, April 2016
Citric acid	$5.57	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Sodium bisulfite	$2.25	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Sulfuric acid (93%)	$1.00	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Antiscalant (100%)	$20.56	$/gal	SVAWPC (2011)
Sodium hydroxide (50%)	$2.88	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Hydrogen peroxide (H_2O_2)	$5.14	$/gal	Per Trojan O&M analysis, assumes NSF drinking water grade, 50% weight by weight
Aqua ammonium	$0.10	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Threshold inhibitor	$19.90	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)

1.4.1.4 Consumables

Assumptions and estimated costs (excluding installation costs) for major consumables related to advanced treatment are summarized in Table 1-11.

Table 1-11. Advanced Treatment Major Consumables1

Element	Consumable Factor	Value	Source
Granular activated carbon media replacement	Replace every 2 years	$61 per cubic foot	Engineering judgement
UV lamp replacement	Replace every 12,000 hours of usage	$195.97 per unit	Valley Water Operations Unit
UV ballast replacement	Replace every 5 years	$794.03 per unit	Valley Water Operations Unit
Membrane replacement – UF	Replace every 3 years	$1,980.26 per unit	Vendor quote
Membrane replacement – MBR	Replace every 3 years	$1,980.26 per unit	Engineering judgment
Membrane replacement – RO	Replace every 5 years	$347.13 per unit	Valley Water Operations Unit
Pumping equipment consumables	--	2% of pumping equipment	Engineering judgment
Electrical consumables	--	2% of electrical costs	Engineering judgment
Instrumentation consumables	--	2% of instrumentation and controls	Engineering judgment

1.4.2 AWPF

AWPF O&M consists of labor, electricity, chemicals, and consumables.

- **Labor** – The annual labor requirements for the AWPF depend on the capacity of the facility, the equipment, and the hours of operation. Each AWPF has a separate staffing plan. AWPF cost estimates include labor required for pump station O&M, such as exercising valves, managing run times for pumps, and examining performance (flow and pressure) data. Routine maintenance may include inspecting equipment, exercising valves, and servicing instrumentation. Labor cost estimates are based on SVAWPC costs and engineering judgment.
- **Energy** – Horsepower sizing for motorized equipment was either provided by vendors or estimated based on facility hydraulics. Electricity estimates for equipment, such as pumps and blowers, are based on equipment horsepower and run times. Electricity rates vary depending on facility location. See Table 1-9 for electricity rates for each site.
- **Chemicals** – Chemical costs for each AWPF are estimated based on dosing amounts provided in the design criteria. Chemical concentration was initially established for 24-mgd facilities and then scaled based on flow.
- **Consumables** – Consumables are estimated based on design criteria and equipment proposals for each AWPF. Costs are project- and site-specific and depend on equipment and electricity rates.

1.4.3 Pipeline

Pipeline O&M consists of labor.

- **Labor** – Pipelines require regularly scheduled maintenance that may include the exercising valves, inspecting appurtenances, and flushing procedures at dead ends. Cost estimates reflect assumed requirement of 1.0 operator hour per year to maintain 100 feet of pipe.

Pipelines require a minimal amount of operational labor resources, as most of the operations occur at the pump station or at the discharge point (i.e., injection well or recharge pond). Therefore, it is assumed that there are no operational labor requirements for pipelines.

1.4.4 Pump Station

Pump station O&M consists of labor, power, and consumables.

- **Labor** – Pump station O&M labor costs are reflected in the estimates for AWPF labor.
- **Energy** – Pump station electricity consumption is estimated by evaluating the total flow, total dynamic head, and an assumed 80 percent pump efficiency.
- **Consumables** – Pump station consumables are valued at 2 percent each of the total equipment, mechanical, electrical, and instrumentation costs associated with the pump station.

1.4.5 Recharge Ponds

Los Gatos Recharge Ponds O&M consists of labor.

- **Labor** – Routine maintenance and cleaning of the percolation ponds is essential to maintaining the ponds' recharge capabilities. Pond maintenance includes the removing sediments, vegetation, and other materials that may limit the ponds' performance, and ripping the soils to improve percolation. Labor costs are escalated from the Expedited Purified Water Program Plan using August 2017 values.

1.4.6 NPR Distribution System

NPR distribution systems do not have separately identified O&M costs. For example, it is assumed that South Bay Water Recycling's (SBWR) NPR+ distribution system expansion would be covered by existing SBWR staff and funding.

1.5 Replacement and Renewal Costs

Assets must be maintained over their life cycles to continue to operate as intended. Assets will require major replacement and renewal over time as elements age beyond their useful lives. The age at which a particular element requires major replacement and renewal varies based on a number of factors, including service conditions, process duty, environmental conditions, materials and quality of construction, and adherence to recommended maintenance procedures. Valley Water has a robust asset management program and evaluates R&R costs as part of the life-cycle cost analysis. BC developed the approach for estimated costs to align with Valley Water's standards and expectations for useful lives of assets.

R&R frequency cycles refer to estimates of how many years it will take for an asset to require replacement or renewal/refurbishment. Cycles used for the life-cycle cost assessment are from three main sources, presented in order of priority reference:

- **Valley Water R&R Frequency Schedule** – Values are from Valley Water's Management Strategy.V.65 worksheet, provided July 2019. The worksheet contains an export of the agency's asset database, including replacement and renewal frequencies for existing specific assets. If equipment specified in Master Plan cost estimates matched assets in the database, these R&R values were used. Exhibit 2 presents the R&R values from the Valley Water asset database that were used to create the life-cycle evaluation.
- **Expedited Purified Water Program Assumptions** – Values are from the Expedited Purified Water Program Plan's basis of cost memorandum. If a given asset did not have values in Valley Water's asset database, these values were used.
- **Standard industry sources** – Values are from BC's database of standard industry and agency sources. If a given asset did not have values in Expedited Purified Water Program Plan's basis of cost memorandum, these values were used.

Replacement costs are 100 percent of the original capital cost for the asset. In the case of packaged estimates, such as for the RO system and all its components, engineers determined the proportion of the original cost to apply to replacement cycles. Renewal costs are a percentage of the original capital cost for the asset. Where no renewal cycle is shown, only a replacement lifecycle is assumed, in addition to annualized operations and maintenance costs. Consumables, such as UV lamp and ballast replacements, are not factored into the R&R cycles.

Table 1-12 provides the expected duration cycles for R&R by asset class and the percentage of original capital cost used to calculate the renewal cost.

Table 1-12. Replacement and Renewal Cycles by Asset Class

Asset Class	Replacement Cycle (years)	Renewal Cycle (years)	Renewal Costs (percent)	Basis of Recommendation
Above and below grade concrete (slabs, pads, vaults, etc.)	100	25	25%	Expedited Purified Water Program
Biologically activated carbon (BAC) system	50	25	75%	Engineer's Estimate
Canopies, steel	75	0	0%	Expedited Purified Water Program
Concrete water tank	100	20	1%	DN Tanks vendor proposal
Decarbonator system	40	20	20%	Expedited Purified Water Program
Electrical Equipment and Accessories	25	0	0%	Valley Water asset database
Flow Meters	10	0	0%	Valley Water asset database
Instrumentation (except flow meters)	20	0	0%	Expedited Purified Water Program
MBR System	50	25	75%	Engineer's Estimate
Metals and Fencing	75	0	0%	Valley Water asset database
NO CAPITAL/R&R COST	0	0	0%	
Ozone system	50	25	75%	Engineer's Estimate
Piping, Conveyance	100	20	4%	Expedited Purified Water Program
Piping, Process (stainless steel or equivalent)	100	0	0%	Replacement - Expedited Purified Water Program; Renewal - Standard industry sources
Process Building (prefabricated steel, single story)	75	0	0%	Valley Water asset database
Pumps, Chemical metering	10	0	0%	Valley Water asset database
Pumps, Process/Product, >200 HP	50	25	30%	Valley Water asset database
Pumps, Process/Product, 100-200 HP	30	15	30%	Valley Water asset database
Pumps, Process/Product, 25-50 HP submersible	15	0	0%	Valley Water asset database
Pumps, Process/Product, 25-75 HP	20	10	30%	Replacement - Valley Water asset database; Renewal - Expedited Purified Water Program
RO System	50	25	75%	Engineer's Estimate
Roadways and Walkways	75	30	25%	Replacement - Valley Water asset database; Renewal - Expedited Purified Water Program
Static Mixers	40	0	0%	Valley Water asset database
Subgrade Structural Piles	70	30	25%	Expedited Purified Water Program
Tanks, Chemical (carbon steel, vertical)	40	8	20%	Replacement - Valley Water asset database; Renewal - Expedited Purified Water Program
Tanks, Chemical (fiberglass reinforced plastic, vertical)	25	8	20%	Expedited Purified Water Program
Tanks, Chemical (high-density polyethylene, vertical)	25	8	20%	Expedited Purified Water Program
Tanks, Process (steel)	50	20	30%	Expedited Purified Water Program
UF system	50	25	75%	Engineer's Estimate
UV System	50	25	75%	Engineer's Estimate
Valves	30	0	0%	Expedited Purified Water Program

1.6 Water Supply Costs

Water supply source costs assume excess flow is available throughout the year, though long-term production is limited due to hydrologic constraints. Long-term production is modeled at 18,500 AFY,[1] except for the Morgan Hill facility (which assumes 2.5 mgd is available for satellite treatment, at no cost). The estimate assumes a standard water supply purchase cost of $100/AF, based on the in-development agreement between Valley Water and Palo Alto ($1 million/year for 9 mgd). Tables 1-13 and 1-14 provide source flow assumptions and annual flow by portfolio, respectively. In the case of Morgan Hill Option 1, the supply cost of $600/AF is assumed based on a rounded "cost recovery rate" provided by city of San Jose staff during a meeting on March 20, 2020.

Table 1-13. Source Flow Assumptions

Item	Value
MF recovery rate	93%
RO recovery rate	85%
Purchase cost ($/AF)[a]	$100

a. *Source water costs may be revisited pending agreements with Partner Agencies.*

Table 1-14. Annual Source Flow by Portfolio

Portfolio	AWPF description	Long-term Production Capacity (AFY)	Max. Annual Source Flow (AFY)
1a	24-mgd plant in San José; full advanced treatment (FAT) process	18,500	23,400
1b	24-mgd plant in San José; FAT process plus ozone-biological activated carbon (BAC)	18,500	23,400
1c & 1d	24-mgd plant in San José; FAT process plus ozone-BAC and chlorine disinfection	18,500	23,400
2a	24.5-mgd plant in Palo Alto (0.5 for NPR+); FAT process	18,500	23,400
2b	24.5-mgd plant in Sunnyvale (0.5 for NPR+); FAT process	18,500	23,400
4	14-mgd plant in Palo Alto; FAT process	10,800	13,700
	10.5-mgd plant in Sunnyvale (0.5 for NPR+); FAT process	7,700	9,700
Westside TWA	24-mgd plant in San José; FAT process plus ozone-BAC and chlorine disinfection	18,500	23,400

Appendix A-6 presents detailed cost estimates, including water supply costs for each portfolio. For the purpose of the life-cycle cost assessment, water supply is included as part of the O&M costs.

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[1] Based on Valley Water's Water Evaluation and Planning System (WEAP) modeling performed for the Expedited Purified Water Program Plan.

1.7 Life-cycle Cost Evaluation

The cost estimates provided in detail in Appendix A-6 form the basis of the life-cycle cost assessment. A life-cycle evaluation captures the full estimated capital cost to construct and implement, operate, and maintain a facility over a set period, and it accounts for both inflation and discounting. For the Master Plan, Valley Water uses a 30-year and 100-year life-cycle cost evaluation to compare and evaluate water supply alternatives.

The life-cycle evaluation evaluates the total cost and dollars per AF of each portfolio over a 30-year and 100-year life-cycle span. The life-cycle evaluation consists of capital; R&R of major equipment; and O&M costs of new treatment facilities, pump stations, pipelines, and water supplies. The life-cycle assessment does not incorporate reverse osmosis concentrate (ROC) management, interties, or NPR distribution costs with the exception of Morgan Hill Option 1, which did include NPR+ distribution costs.

The life-cycle evaluation calculates present value costs. Present value costs convert future payments—e.g., costs that will need to be paid in 10 or 50 years—to today's dollars. It takes into consideration a fundamental principle of business finance: the time value of money, in which one dollar today has greater value than one dollar in the future. The time value of money is affected by inflation, which decreases purchasing power, and opportunity cost (such as foregoing money that could have been invested to gain more money). This life-cycle analysis evaluates future potential spend over a fixed period while controlling for inflation and for the discount rate, which adjusts future cash flows to the present day.

Table 1-15 summarizes the life-cycle factors and assumptions affecting the life-cycle cost assessment.

Table 1-15. Life-cycle Factors and Assumptions

Element	Notes
Discount rate	Valley Water uses a discount rate of 5.5%.
Inflation rate	Valley Water uses a cost escalation (inflation) rate of 3.0%.
Real discount rate	Valley Water applies a real discount rate of 2.43% based on a 5.5% discount rate and 3% inflation rate. The real discount rate was applied to the projected expenditures to identify the 2019 present value of projected expenditures. The real discount rate formula is ((1+discount rate)/(1+inflation rate))-1.
Base year	The base year for nominal dollars is 2019.
Salvage value	Remaining salvage value at the end of the 100-year period is not considered in the life-cycle evaluation.
Implementation and construction period	Capital expenditure associated with design, implementation, and construction are anticipated to begin in 2024 for most facilities and end in 2027.
Operational period	Facilities are projected to start operation in 2028 and operate for 100 years to 2127.

Consistent with Valley Water's unit life-cycle methodology, the annual water supply yields are discounted at the real discount rate (2.43%), based on a 5.5% discount rate and 3% inflation rate. The real discount rate was applied to the projected expenditures to estimate the total "present value yield" for a supply alternative. Remaining salvage value at the end of the 100-year period is not considered in the life-cycle evaluation. The total present value cost is then divided by the total present value yield of that component to determine the life-cycle unit cost ($/AF).

Table 1-16 provides key references for the economic comparison of life cycles.

Table 1-16. References for Economic Comparison of Life Cycles

Term	Description
Estimated capital	Estimated nominal (not accounting for inflation or discounting) capital costs for the entire life cycle, represented in August 2019 dollars
Estimated O&M	Estimated nominal (not accounting for inflation or discounting) O&M costs for the entire life cycle, represented in August 2019 dollars Water supply source costs ($2.5M/year per portfolio) are included in this estimate. (Source water costs may be revisited pending agreements with Partner Agencies.)
Estimated R&R	Estimated nominal (not accounting for inflation or discounting) costs for R&R of major equipment, represented in August 2019 dollars
Total cost	Sum of estimated nominal (not accounting for inflation or discounting) capital, O&M, and R&R costs, represented in August 2019 dollars
Total cost, present value	Current value of estimated capital, O&M, and R&R costs that will be incurred over the project lifespan. Present value costs reflect Valley Water's real discount rate (2.43%; costs inflated at 3% and then discounted back to current dollars at 5.5%), represented in 2019 dollars Assumes construction begins in 2024 and operations begin in 2028
Annual yield	Average water supply system yield, represented in AF Assumes yield per portfolio is 18,500 AFY
Present value yield	Per Valley Water's unit life-cycle approach, annual water supply system yields are discounted at the real discount rate (2.43%), represented in AF
Life-cycle unit cost	Present value cost divided by the present value yield, represented in $/AF

The format for the life-cycle cost summary contains fields for estimated nominal costs and present value costs (represented in 2019 dollars), water supply system yields (represented in AF), and life-cycle unit costs (represented in $/AF) for the 30-year and 100-year life cycles for each portfolio. Section 5 of the Feasible Project Portfolios summarizes the life-cycle costs for each portfolio.

Actual results of the life-cycle evaluation for each portfolio are in Appendix A-6.

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Exhibit 1: AWPF Unit Costs

This exhibit provides a list of AWPF capital and O&M unit costs.

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Exhibit 1

Unit Costs (Construction and O&M)

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
O&M	Labor		Water Plant Operator	$/hr	$ 163.20	1.00	$ 163.20	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Labor		Sr Mechanics	$/hr	$ 172.27	1.00	$ 172.27	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Labor		Control Tech II	$/hr	$ 172.27	1.00	$ 172.27	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Labor		Supervisor	$/hr	$ 166.58	1.00	$ 166.58	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Power		Electricity - San Jose	$/kWh	$ 0.10	1.00	$ 0.10	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		SVAWPC Rate
O&M	Power		Electricity - Sunnyvale	$/kWh	$ 0.16	1.00	$ 0.16	PG&E		
O&M	Power		Electricity - Palo Alto	$/kWh	$ 0.19	1.00	$ 0.19	Palo Alto Utility		
O&M	Chemicals		Calcium Chloride	$/gal	$ 0.53	1.03	$ 0.54	City of Los Angeles Groundwater Replenishment Master Planning Report, Appendix B, Table B-2		
O&M	Chemicals		Sodium Hypochlorite	$/gal	$ 0.61	1.00	$ 0.61	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Chemicals		Citric Acid	$/gal	$ 5.57	1.00	$ 5.57	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Chemicals		Sodium Bisulfite	$/gal	$ 2.25	1.00	$ 2.25	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		based on $618.64 per tote
O&M	Chemicals		Sulfuric Acid (93%)	$/gal	$ 1.00	1.00	$ 1.00	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		based on $139.87 per ton
O&M	Chemicals		Antiscalant (100%)	$/gal	$ 16.82	1.22	$ 20.56	SVAWPC (2011)		SVAWPC Chemical Cost.msg (confidential folder); based on $1.92/lb
O&M	Chemicals		Sodium Hydroxide (50%)	$/gal	$ 2.88	1.00	$ 2.88	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Chemicals		Hydrogen Peroxide (H_2O_2)	$/gal	$ 5.00	1.03	$ 5.14	Per Trojan O&M analysis		assumes NSF drinking water grade, 50% w/w
O&M	Chemicals		Aqueous Ammonium	$/gal	$ 0.10	1.00	$ 0.10	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Chemicals		Threshold Inhibitor	$/gal	$ 19.90	1.00	$ 19.90	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Consumables		MF Membrane Module Replacement	$/unit	$ 1,850	1.07	$ 1,980.26	From Yuba City ACWD-USD (April 2016)		vendor quote
O&M	Consumables		RO Module Replacement	$/unit	$ 347	1.00	$ 347.13	Valley Water Operations Unit / O&M info for Existing SVAWPC, August 2019 - SVAWPC Rate		vendor quote
O&M	Consumables		UV Lamp Replacement	$/unit	$ 196	1.00	$ 195.97	Valley Water Operations Unit / O&M info for Existing SVAWPC, August 2019 - SVAWPC Rate		vendor quote
O&M	Consumables		UV Ballast Replacement	$/unit	$ 794	1.00	$ 794.03	Valley Water Operations Unit / O&M info for Existing SVAWPC, August 2019 - SVAWPC Rate		vendor quote

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
O&M	Consumables		Decarbonator Media	$/cubic foot	$ 52	1.07	$ 55.66	vendor quote		8/23/2016, Westech forced draft
Division 40 – Process Integration	Conduit		PVC Conduit 2"	$/LF	$ 7.35	1.32	$ 9.67	RS Means (2017)	*26.05.39.30.3350*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		PVC Conduit, 1" Dia.	$/LF	$ 4.23	1.32	$ 5.57	RS Means (2017)	*26.05.39.30.3270*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		PVC Conduit, 0.75" Dia	$/LF	$ 3.57	1.32	$ 4.70	RS Means (2017)	*26.05.39.30.3250*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		#14 Wire, 2 conductor	$/LF	$ 1.97	1.32	$ 2.59	RS Means (2017)	*26.05.19.55.1450*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#12 Wire, 2 Conductor	$/LF	$ 2.35	1.32	$ 3.09	RS Means (2017)	*26.05.19.55.1500*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#10 Wire, 2 Conductor	$/LF	$ 2.90	1.32	$ 3.82	RS Means (2017)	*26.05.19.55.1550*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#14 Wire, 3 conductor	$/LF	$ 2.33	1.32	$ 3.07	RS Means (2017)	*26.05.19.55.1600*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#12 Wire, 3 Conductor	$/LF	$ 2.85	1.32	$ 3.75	RS Means (2017)	*26.05.19.55.1650*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#10 Wire, 3 Conductor	$/LF	$ 3.65	1.32	$ 4.80	RS Means (2017)	*26.05.19.55.1700*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		Rigid Steel Conduit 2"	$/LF	$ 17.50	1.32	$ 23.03	RS Means (2017)	*26.05.39.30.4800*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		Rigid Steel Conduit, 1" Dia.	$/LF	$ 12.55	1.32	$ 16.51	RS Means (2017)	*26.05.39.30.4450*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		Rigid Steel Conduit, 0.75" Dia.	$/LF	$ 8.75	1.32	$ 11.51	RS Means (2017)	*26.05.39.30.4400*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		Junction Box (6"x6"x6")	$/EA	$ 87	1.32	$ 113.81	RS Means (2017)	*26.05.33.18.2150*	NEMA 3R, type SC, raintight and weatherproof
Division 11 – Equipment	Conduit		Precast Electrical Handhole (3'x3'x3')	$/EA	$ 1,600	1.32	$ 2,105.15	RS Means (2017)	*33.71.19.17.0800*	
Division 11 – Equipment	Rental		Backhoe Rental	$/month	$ 5,825	1.32	$ 7,664.05	RS Means (2017)	*01.54.33.20.0470*	112hp, 1-1/2 CY capacity
Division 11 – Equipment	Rental		Backhoe Rental	$/week	$ 1,945	1.32	$ 2,559.07	RS Means (2017)	*01.54.33.20.0470*	112hp, 1-1/2 CY capacity
Division 11 – Equipment	Rental		Forklift	$/month	$ 4,675	1.32	$ 6,150.98	RS Means (2017)	*01.54.33.40.2050*	rough terrain, 42' lift, 35' reach, 9000lb, 110hp
Division 11 – Equipment	Rental		Forklift	$/week	$ 1,555	1.32	$ 2,045.94	RS Means (2017)	*01.54.33.40.2050*	rough terrain, 42' lift, 35' reach, 9000lb, 110hp
Division 11 – Equipment	Rental		Crane	$/month	$ 4,725	1.32	$ 6,216.76	RS Means (2017)	*01.54.33.60.3050*	self-propelled, 4x4, w/ telescoping boom, 20 ton
Division 11 – Equipment	Rental		Crane	$/week	$ 1,575	1.32	$ 2,072.25	RS Means (2017)	*01.54.33.60.3050*	self-propelled, 4x4, w/ telescoping boom, 20 ton
Division 11 – Equipment	Rental		Barge	$/month	$ 9,800	1.32	$ 12,894.03	RS Means (2017)	*01.54.33.80.0200*	400 ton, 30' x 90'
Division 11 – Equipment	Rental		Barge	$/week	$ 3,265	1.32	$ 4,295.82	RS Means (2017)	*01.54.33.80.0200*	400 ton, 30' x 90'
Division 31 – Earthwork			Trench Excavation Cost (6' - 10' deep)	$/CY	$ 4.95	1.00	$ 4.95	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.13.0510*	common earth with not sheeting or dewatering included, 1 CY excavator
Division 31 – Earthwork			Trench Excavation Cost (10' - 14' deep)	$/CY	$ 5.50	1.00	$ 5.50	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.13.0910*	common earth with not sheeting or dewatering included, 1 CY excavator
Division 31 – Earthwork			Trench Excavation Cost (14' - 20' deep)	$/CY	$ 6.18	1.00	$ 6.18	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.13.1300*	common earth with not sheeting or dewatering included, 1 CY excavator
Division 31 – Earthwork			Shoring, Sheet Piling Steel, 15'	$/SF	$ 24.61	1.00	$ 24.61	RS Means (2019) - raw unit costs have location factor embedded in it	*31.41.16.10.1300*	sheeting excavation (drive, extract, salvage)
Division 31 – Earthwork			Shoring, Sheet Piling Steel, 25'	$/SF	$ 30.41	1.00	$ 30.41	RS Means (2019) - raw unit costs have location factor embedded in it	*31.41.16.10.1900*	sheeting excavation (drive, extract, salvage)
Division 31 – Earthwork			Shoring, Wood Sheeting, 8'	$/SF	$ 12.18	1.00	$ 12.18	RS Means (2019) - raw unit costs have location factor embedded in it	*31.41.16.10.3910*	sheeting excavation (drive, extract, salvage)
Division 31 – Earthwork			Clear and Grub Site	$/Acre	$ 7,760.00	1.00	$ 7,760.00	RS Means (2019) - raw unit costs have location factor embedded in it	*31.11.10.10.0020*	
Division 31 – Earthwork			Strip Topsoil	$/SY	$ 0.85	1.00	$ 0.85	RS Means (2019) - raw unit costs have location factor embedded in it	*31.14.13.23/155-*	For areas 1101-4000 SY by dozer

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 31 – Earthwork			Structure Excavation	$/CY	$ 11.78	1.00	$ 11.78	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.16.6060*	machine excavation, for spread and mat footings, elevator pits, small building foundations, 2 CY bucket
Division 31 – Earthwork			Sheepsfoot Compaction	$/CY	$ 0.89	1.00	$ 0.89	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.23.23.5720*	12" lifts, 4 passes
Division 31 – Earthwork			Site Grading (small, irregular areas)	$/SY	$ 2.97	1.00	$ 2.97	RS Means (2019) - raw unit costs have location factor embedded in it	*31.22.16.10.1050*	small, irregular areas
Division 31 – Earthwork			Site Grading (for large parking lots)	$/SY	$ 1.18	1.00	$ 1.18	RS Means (2019) - raw unit costs have location factor embedded in it	*31.22.16.10.1020*	large parking lots
Division 31 – Earthwork			Backfilling (trench)	$/CY	$ 12.44	1.00	$ 12.44	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.13.3060*	1 CY bucket, 200'
Division 31 – Earthwork			Backfill (structural)	$/CY	$ 1.04	1.00	$ 1.04	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.23.14.4020*	200 HP, 50' haul, common earth from stockpile
Division 31 – Earthwork			Material haul	$/CY	$ 8.88	1.00	$ 8.88	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.23.20.4112*	20 CY truck, 15 min wait, 50 MPH, cycle 40 miles (approx distance from San Martin to SVAWPC)
Division 31 – Earthwork			Aggregate Base	$/CY	$ 49.61	1.00	$ 49.61	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.23.16.0050*	crushed or screened bank run gravel
Division 31 – Earthwork			Aggregate Base with Material Hauling	$/CY	$ 58.49	1.00	$ 58.49	*See Above*		crushed or screened bank run gravel; 20 CY truck, 15 min wait, 50 MPH, cycle 40 miles (approx distance from San Martin to SVAWPC)
Division 31 – Earthwork			Base Course Drainage (Gravel)	$/SY	$ 4.63	1.00	$ 4.63	RS Means (2019) - raw unit costs have location factor embedded in it	*32.11.23.23.0050*	crushed 3/4" stone base, compacted, 3" deep
Division 31 – Earthwork			Subgrade Structural Piles Fabrication and delivery	$/SF	$ 68.38	1.22	$ 83.60	SVAWPC (2011)		14'x14' prestressed concrete piles, fabrication/ delivery- SVAWPC interprocess and product water storage tanks
Division 31 – Earthwork			Subgrade Structural Piles	$/SF	$ 47.12	1.22	$ 57.60	SVAWPC (2011)		14'x14' prestressed concrete piles including installation, SVAWPC interprocess tank -5ft spacing between piles
Division 31 – Earthwork			Subgrade Structural Piles	$/SF	$ 5.29	1.22	$ 6.47	SVAWPC (2011)		14'x14' prestressed concrete piles including installation, SVAWPC product water tank -5 ft 10in between piles
Division 31 – Earthwork			Flowable Fill - 40-80 psi	$/CY	$ 88.50	1.32	$ 116.44	RS Means (2017)	*03.31.13.35.4100*	Ash, cement aggregate, water / (identical to CLSM)
Division 31 – Earthwork			Flowable fill Structural - 50 psi	$/CY	$ 88.50	1.32	$ 116.44	RS Means (2017)	*03.31.13.35.4200*	Ash, cement, aggregate, water and sand
Division 31 – Earthwork			Flowable fill Structural - 140 psi	$/CY	$ 89.50	1.32	$ 117.76	RS Means (2017)	*03.31.13.35.4250*	Ash, cement, aggregate, water and sand
Division 31 – Earthwork			Flowable fill Structural - 500 psi	$/CY	$ 92.50	1.32	$ 121.70	RS Means (2017)	*03.31.13.35.4300*	Ash, cement, aggregate, water and sand
Division 31 – Earthwork			Flowable fill Structural - 1000 psi	$/CY	$ 96.00	1.32	$ 126.31	RS Means (2017)	*03.31.13.35.4350*	Ash, cement, aggregate, water and sand
Division 31 – Earthwork			Bituminous concrete, 4" thick [asphalt]	$/SF	$ 2.01	1.00	$ 2.01	RS Means (2019) - raw unit costs have location factor embedded in it	32.11.26.13.0500	Plant mix asphaltic base courses for roadways and large paved areas
Division 31 – Earthwork			Sawcut 4" Pavement	$/LF	$ 3.70	1.00	$ 3.70	RS Means (2019) - raw unit costs have location factor embedded in it		From Pleasanton estimate
Division 31 – Earthwork			Dewatering	$/CY	$ 17.16	1.00	$ 17.16	RS Means (2019) - raw unit costs have location factor embedded in it	31.23.19.20 0020	
Division 31 – Earthwork			Rotary Lobe Blower, 5.5 bhp	$/EA	$ 4,800	1.32	$ 6,315.44	RS Means (2017)	46.51.20.10.0430	125 cfm, includes 3 phase motor, filter, silencer, valves, check valve, pressure gage
Division 31 – Earthwork			Sump pumps, 1/2HP, 1-1/4" discharge	$/EA	$ 480	1.32	$ 631.54	RS Means (2017)	22.14.29.16.7560	cast iron, submersible
Division 31 – Earthwork			Sump pumps, 30HP, 6" discharge	$/EA	$ 10,200	1.32	$ 13,420.31	RS Means (2017)	22.14.29.13.2090	wet-pit-mounted, vertical sump pumps, 1000 GPM
Division 46 – Water and Wastewater Equipment			Automatic Strainer	$/EA	$ 13,750	1.22	$ 16,810.80	SVAWPC (2011)		SCAWPC cost; $/EA estimated per (4) automatic strainers

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 46 – Water and Wastewater Equipment			Static Mixer	$/EA	$ 9,700	1.25	$ 12,132.39	Based on quote for NSD Contract D for static mixer (September 2010)		0.2 mgd, min flow; 1.5 mgd, normal flow; 5.1 max flow; pressure drop across max flow - 5.4 psig
Division 46 – Water and Wastewater Equipment	Steel Tanks		250,000 gal steel water storage tank	$/EA	$ 443,250	1.00	$ 443,250.00	RS Means (2019) - raw unit costs have location factor embedded in it	33.16.13.13 1000	Not including foundation; adding installation factor
Division 46 – Water and Wastewater Equipment	Steel Tanks		375,000 gal steel water storage tank	$/EA	$ 534,375	1.00	$ 534,375.00	RS Means (2019) - raw unit costs have location factor embedded in it		Interpolated
Division 46 – Water and Wastewater Equipment	Steel Tanks		500,000 gal steel water storage tank	$/EA	$ 625,500	1.00	$ 625,500.00	RS Means (2019) - raw unit costs have location factor embedded in it	33.16.13.13 1200	Not including foundation; adding installation factor
Division 46 – Water and Wastewater Equipment	Steel Tanks		750,000 gal steel water storage tank	$/EA	$ 807,000	1.00	$ 807,000.00	RS Means (2019) - raw unit costs have location factor embedded in it	33.16.13.13 1250	Not including foundation; adding installation factor
Division 08 – Doors and Windows	Building Specialties		Doors and Hardware	$/LS	$ 35,000	1.22	$ 42,791.12	SVAWPC (2011)		SVAWPC cost; assumed LS
Division 08 – Doors and Windows	Building Specialties		Overhead Doors	$/LS	$ 50,000	1.22	$ 61,130.17	SVAWPC (2011)		SVAWPC cost; assumed LS
Division 08 – Doors and Windows	Building Specialties		Windows	$/LS	$ 50,000	1.22	$ 61,130.17	SVAWPC (2011)		SVAWPC cost; assumed LS
Division 08 – Doors and Windows	Building Specialties		Showers and Lockers	$/LS	$ 17,400	1.22	$ 21,273.30	SVAWPC (2011)		SVAWPC installed cost; assumed 50% installation to get material cost
Division 08 – Doors and Windows	Building Specialties		Sinks and Toilets	$/LS	$ 12,000	1.22	$ 14,671.24	SVAWPC (2011)		SVAWPC installed cost; assumed 50% installation to get material cost
Division 08 – Doors and Windows	Building Specialties		Bollards, 6" diameter	$/EA	$ 770	1.32	$ 1,013.10	RS Means (2017)	32.17.13.13.1300	concrete filled/paint, 8' L x 4' D hole, 6" diameter
Division 08 – Doors and Windows	Building Specialties		Pre-Fab Steel Bldg	$/SF	$ 25.00	1.32	$ 32.89	RS Means (2017)	13.34.19.50.0400	30' to 49' wide, 16' eave height
Division 08 – Doors and Windows	Building Specialties		Single Leaf Door	$/EA	$ 1,175	1.32	$ 1,545.97	RS Means (2017)	13.34.19.50.5825	
Division 08 – Doors and Windows	Building Specialties		Double Leaf Door	$/EA	$ 2,275	1.32	$ 2,993.26	RS Means (2017)	13.34.19.50.6000	
Division 08 – Doors and Windows	Building Specialties		Eave Overhang	$/LF	$ 54.50	1.32	$ 71.71	RS Means (2017)	13.34.19.50.5250	2' wide, 26 ga., with soffit
Division 08 – Doors and Windows	Building Specialties		Flashings	$/LF	$ 11.20	1.32	$ 14.74	RS Means (2017)	13.34.19.50.6250	26 ga., corner, or eave, painted
Division 08 – Doors and Windows	Building Specialties		Gutters	$/LF	$ 12.60	1.32	$ 16.58	RS Means (2017)	13.34.19.50.6550	gutter, eave type, 26 ga. Painted
Division 08 – Doors and Windows	Building Specialties		Insulation	$/SF	$ 1.83	1.32	$ 2.41	RS Means (2017)	13.34.19.50.6730	10" thick, R30
Division 08 – Doors and Windows	Building Specialties		Windows	$/EA	$ 1,100	1.32	$ 1,447.29	RS Means (2017)	13.34.19.50.7800	sash, single slide, glazed, with screens 6040 (6'x4')
Division 08 – Doors and Windows	Building Specialties		Skylight	$/EA	$ 365	1.32	$ 480.24	RS Means (2017)	13.34.19.50.8200	fiberglass panels, to 30 SF
Division 08 – Doors and Windows	Building Specialties		Stairs	$/RISER	$ 525	1.32	$ 690.75	RS Means (2017)	05.51.19.50.0020	grating stairs, grating tread and pipe railing, 3.5' wide
Division 08 – Doors and Windows	Building Specialties		Handrails	$/LF	$ 63	1.32	$ 82.23	RS Means (2017)	05.52.13.50.0560	steel, 2 rail, on stairs, galvanized, 1-1/2" diameter
Division 08 – Doors and Windows	Building Specialties		Landing	$/SF	$ 107	1.32	$ 140.78	RS Means (2017)	05.51.13.50.1500	
Division 08 – Doors and Windows	Building Specialties		Eyewash/Shower	$/EA	$ 5,000	1.32	$ 6,578.59	grainger		HAWS stainless steel, installed; January 2016 number (based on previous estimates)
Division 08 – Doors and Windows	Building Specialties		Precast Polymer Trench Drain	$/LF	$ 61.50	1.32	$ 80.92	RS Means (2017)	22.14.26.19.6680	not including trenching, heavy duty iron grate
Division 08 – Doors and Windows	Building Specialties		Precast Beam - 30' Span 24"x36"	$/LF	$ 291	1.32	$ 382.61	RS Means (2017)	B1010.213.7100	
Division 13 – Special Construction	Building Material		Prefabricated Building	$/SF	$ 179	1.22	$ 218.58	SVAWPC (2011)	RSMeans lists $14.70 for non-furnished building cost (13.34.19.50.4200)	installed cost; SCAWPC cost; $/SF estimated with area of process building, 135'x235'
Division 13 – Special Construction	Building Material		Canopy	$/SF	$ 74	1.22	$ 90.93	SVAWPC (2011)		installed cost; SVAWPC cost; $/SF estimated with area of chemical storage canopy at 10'x26'
Division 32 – Exterior Improvements	Building Material		Chain Link Fence	$/LF	$ 53	1.00	$ 52.94	RS Means (2019) - raw unit costs have location factor embedded in it	*32.31.13.20.0940*	Aluminized steel, 6 ga., Wire, 2" posts @ 10' OC, 6' high, includes excavation and concrete
Division 03 – Concrete	Concrete		Glazed Concrete Block	$/SF	$ 44.92	1.00	$ 44.92	RS Means (2019) - raw unit costs have location factor embedded in it	04.22.10.44.0800	double face, 8" x 16" units, 8" thick
Division 03 – Concrete	Concrete		Retaining Wall	$/CY	$ 513.21	1.00	$ 513.21	RS Means (2019) - raw unit costs have location factor embedded in it	03.30.53.40.6200	gravity, 4' high (more expensive than 10' high wall and is the same as 8' cantilever wall)

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 03 – Concrete	Concrete		Concrete - Slab on grade	$/CY	$ 645.00	1.00	$ 645.00	Created Sage Assy. (via Des)		Assume 14" thick slab, thickened edge, fine grading incl, 6" base, edge forms, 140#/cy rebar, 10' x 20' slab, CJs, waterstops
Division 03 – Concrete	Concrete		Concrete - 10" Elevated Slab	$/CY	$ 1,150.00	1.00	$ 1,150.00	Created Sage Assy. (via Des)		
Division 03 – Concrete	Concrete		Concrete - 14" Walls	$/CY	$ 1,090.00	1.00	$ 1,090.00	Created Sage Assy. (via Des)		
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		4"	$/EA	$ 1,225	1.32	$ 1,611.75	RS Means (2017)	*33.12.16.10.3810*	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		6"	$/EA	$ 1,725	1.32	$ 2,269.61	RS Means (2017)	*33.12.16.10.3814*	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		8"	$/EA	$ 2,725	1.32	$ 3,585.33	RS Means (2017)	*33.12.16.10.3816*	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		10"	$/EA	$ 4,500	1.32	$ 5,920.73	estimate		
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		12"	$/EA	$ 6,200	1.32	$ 8,157.45	RS Means (2017)	*33.12.16.10.3820*	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		16"	$/EA	$ 18,800	1.32	$ 24,735.48	RS Means (2017)	*33.12.16.10.3824*	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		20"	$/EA	$ 31,200	1.32	$ 41,050.38	RS Means (2017)	*33.12.16.10.3828*	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		24"	$/EA	$ 45,900	1.32	$ 60,391.42	RS Means (2017)	*33.12.16.10.3830*	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		30"	$/EA	$ 43,300	1.32	$ 56,970.55	RS Means (2017)	*33.12.16.10.3831*	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		36"	$/EA	$ 69,000	1.32	$ 90,784.48	RS Means (2017)	*33.12.16.10.3832*	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		4"	$/EA	$ 895	1.32	$ 1,177.57	RS Means (2017)	*33.12.16.10.3100*	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		8"	$/EA	$ 1,275	1.32	$ 1,677.54	RS Means (2017)	*33.12.16.10.3180*	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		12"	$/EA	$ 2,050	1.32	$ 2,697.22	RS Means (2017)	*33.12.16.10.3340*	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		14"	$/EA	$ 4,050	1.32	$ 5,328.65	RS Means (2017)	*33.12.16.10.3400*	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		18"	$/EA	$ 6,700	1.32	$ 8,815.30	RS Means (2017)	*33.12.16.10.3460*	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		20"	$/EA	$ 8,650	1.32	$ 11,380.95	RS Means (2017)	*33.12.16.10.3480*	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		24"	$/EA	$ 14,100	1.32	$ 18,551.61	RS Means (2017)	*33.12.16.10.3500*	
Division 33 – Utilities	Air Release Valve for Water		1/2" inlet	$/EA	$ 132	1.32	$ 173.67	RS Means (2017)	*33.12.16.20.1000*	
Division 33 – Utilities	Air Release Valve for Water		3/4" inlet	$/EA	$ 132	1.32	$ 173.67	RS Means (2017)	*33.12.16.20.1005*	
Division 33 – Utilities	Air Release Valve for Water		1" inlet	$/EA	$ 139	1.32	$ 182.88	RS Means (2017)	*33.12.16.20.1010*	
Division 33 – Utilities	Air Release Valve for Water		2" inlet	$/EA	$ 345	1.32	$ 453.92	RS Means (2017)	*33.12.16.20.1020*	
Division 22 – Plumbing	Pipes		Reduced Pressure Backflow Preventor, flanged bronze (2-1/2")	$/EA	$ 5,875	1.32	$ 7,729.84	RS Means (2017)	*22.11.19.42.5060*	includes valves and four test cocks, corrosion resistant, automatic operation
Division 33 – Utilities	Pipes		Fire Hydrant (5.25" valve, 8ft deep)	$/EA	$ 3,250	1.32	$ 4,276.08	RS Means (2017)	*33.12.19.10.2240*	
Division 33 – Utilities	Pipes		Pipe Bedding Material	$/CY	$ 41.50	1.32	$ 54.60	RS Means (2017)	*31.23.23.16.0100*	not including compaction, loose
Division 33 – Utilities	Pipes		PVC Pipe Joint Restraint, 24" dia	$/EA	$ 895	1.32	$ 1,177.57	RS Means (2017)	*33.11.13.25.8790*	
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		4" Pipe	$/LF	$ 51	1.32	$ 67.10	RS Means (2017)	*33.11.13.15.2020*	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		6" Pipe	$/LF	$ 51	1.32	$ 67.10	RS Means (2017)	*33.11.13.15.2040*	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		8" Pipe	$/LF	$ 75	1.32	$ 98.68	RS Means (2017)	*33.11.13.15.2060*	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		10" Pipe	$/LF	$ 95	1.32	$ 124.34	RS Means (2017)	*33.11.13.15.2080*	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		12" Pipe	$/LF	$ 120	1.32	$ 157.89	RS Means (2017)	*33.11.13.15.2100*	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		14" Pipe	$/LF	$ 137	1.32	$ 180.25	RS Means (2017)	*33.11.13.15.2120*	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		16" Pipe	$/LF	$ 152	1.32	$ 199.99	RS Means (2017)	*33.11.13.15.2140*	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		20" Pipe	$/LF	$ 201	1.32	$ 264.46	RS Means (2017)	*33.11.13.15.2170*	cement lined, not including excavation or backfill

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		24" Pipe	$/LF	$ 229	1.32	$ 301.30	RS Means (2017)	*33.11.13.15.2180*	cement lined, not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 18		4"	$/LF	$ 10	1.32	$ 12.50	RS Means (2017)	*33.11.13.25.4520*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 19		6"	$/LF	$ 13	1.32	$ 17.10	RS Means (2017)	*33.11.13.25.4530*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 20		8"	$/LF	$ 17	1.32	$ 22.89	RS Means (2017)	*33.11.13.25.4540*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 21		10"	$/LF	$ 24	1.32	$ 31.58	RS Means (2017)	*33.11.13.25.4550*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 22		12"	$/LF	$ 30	1.32	$ 39.47	RS Means (2017)	*33.11.13.25.4560*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 23		24"	$/LF	$ 60	1.32	$ 78.94	extrapolated		not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 25		14	$/LF	$ 25	1.32	$ 32.89	RS Means (2017)	*33.11.13.25.3030*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 26		16	$/LF	$ 32	1.32	$ 41.45	RS Means (2017)	*33.11.13.25.3040*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 27		18	$/LF	$ 40	1.32	$ 51.97	RS Means (2017)	*33.11.13.25.3050*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 28		20	$/LF	$ 49	1.32	$ 63.81	RS Means (2017)	*33.11.13.25.3060*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 29		24	$/LF	$ 68	1.32	$ 89.47	RS Means (2017)	*33.11.13.25.3070*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 30		30	$/LF	$ 115	1.32	$ 151.31	RS Means (2017)	*33.11.13.25.3080*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 31		36	$/LF	$ 163	1.32	$ 214.46	RS Means (2017)	*33.11.13.25.3090*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 32		42	$/LF	$ 201	1.32	$ 264.46	RS Means (2017)	*33.11.13.25.3100*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 33		48	$/LF	$ 250	1.32	$ 328.93	RS Means (2017)	*33.11.13.25.3200*	not including excavation or backfill
Division 33 – Utilities	PVC with excavation, backfill and speed shoring		12	$/LF	$ 632	1.32	$ 832.17	RMC, not identified (2017)		Source for 139.5 ft of pipe; Jan 2017 CCI for SF
Division 33 – Utilities	Chemical Pipes		1-1/2" to 2"	$/LF	$ 92	1.32	$ 121.05	RS Means (2017)	*22.66.53.60.1000*	
Division 33 – Utilities	Chemical Pipes		2"	$/LF	$ 95	1.32	$ 124.99	RS Means (2017)	*22.66.53.60.1100*	
Division 33 – Utilities	Insulated Pipes - Chilled/HVAC Hot Water Distribtuion		2"	$/LF	$ 51	1.32	$ 66.44	RS Means (2017)	*33.61.13.10.1030*	
Division 33 – Utilities	Insulated Pipes - Chilled/HVAC Hot Water Distribtuion		8"	$/LF	$ 119	1.32	$ 156.57	RS Means (2017)	*33.61.13.10.1090*	
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		4"	$/LF	$ 11	1.32	$ 14.80	RS Means (2017)	*33.11.13.35.0100*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		6"	$/LF	$ 12	1.32	$ 16.25	RS Means (2017)	*33.11.13.35.0200*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		8"	$/LF	$ 19	1.32	$ 25.26	RS Means (2017)	*33.11.13.35.0300*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		10"	$/LF	$ 26	1.32	$ 33.55	RS Means (2017)	*33.11.13.35.0400*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		12"	$/LF	$ 36	1.32	$ 47.37	RS Means (2017)	*33.11.13.35.0500*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		14"	$/LF	$ 50	1.32	$ 65.13	RS Means (2017)	*33.11.13.35.0600*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		16"	$/LF	$ 60	1.32	$ 78.29	RS Means (2017)	*33.11.13.35.0700*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		18"	$/LF	$ 92	1.32	$ 121.05	RS Means (2017)	*33.11.13.35.0800*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		24"	$/LF	$ 118	1.32	$ 155.25	RS Means (2017)	*33.11.13.35.0900*	not including excavation or backfill
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		10"	$/LF	$ 193	1.32	$ 253.93	RS Means (2017)	*22.11.13.48.1150*	includes coupling &celvis type hanger assemblies
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		12"	$/LF	$ 218	1.32	$ 286.83	RS Means (2017)	*22.11.13.48.1160*	includes coupling &celvis type hanger assemblies
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		14"	$/LF	$ 248	1.32	$ 326.30	RS Means (2017)	*22.11.13.48.1170*	includes coupling &celvis type hanger assemblies
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		20"	$/LF	$ 425	1.32	$ 559.18	RS Means (2017)	*22.11.13.48.1200*	includes coupling &celvis type hanger assemblies
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		24"	$/LF	$ 495	1.32	$ 651.28	RS Means (2017)	*22.11.13.48.1210*	includes coupling &celvis type hanger assemblies

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 09 – Finishes	Steel Pipes, Schedule 40, black		Exterior Steel Coating	$/SF	$ 1.01	1.32	$ 1.33	RS Means (2017)	*09.97.13.23.6910*	Universal primers, one part, phenolic, modified alkyd
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 8"x6"	$/EA	$ 540	1.32	$ 710.49	RS Means (2017)	*33.11.13.15.8460*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 10"x6"	$/EA	$ 690	1.32	$ 907.84	RS Means (2017)	*33.11.13.15.8470*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 12"x6"	$/EA	$ 880	1.32	$ 1,157.83	RS Means (2017)	*33.11.13.15.8480*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 14"x6"	$/EA	$ 1,103	1.32	$ 1,450.58	interpolated		
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 16"x6"	$/EA	$ 1,325	1.32	$ 1,743.33	RS Means (2017)	*33.11.13.15.8490*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 20"x6"	$/EA	$ 2,175	1.32	$ 2,861.68	RS Means (2017)	*33.11.13.15.8500*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		4" 90 deg elbow	$/EA	$ 315	1.32	$ 414.45	RS Means (2017)	*33.11.13.15.8006*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		6" 90 deg elbow	$/EA	$ 435	1.32	$ 572.34	RS Means (2017)	*33.11.13.15.8020*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		8" 90 deg elbow	$/EA	$ 715	1.32	$ 940.74	RS Means (2017)	*33.11.13.15.8040*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		10" 90 deg elbow	$/EA	$ 985	1.32	$ 1,295.98	RS Means (2017)	*33.11.13.15.8060*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		12" 90 deg elbow	$/EA	$ 1,300	1.32	$ 1,710.43	RS Means (2017)	*33.11.13.15.8080*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		14" 90 deg elbow	$/EA	$ 1,825	1.32	$ 2,401.18	RS Means (2017)	*33.11.13.15.8100*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		16" 90 deg elbow	$/EA	$ 2,300	1.32	$ 3,026.15	RS Means (2017)	*33.11.13.15.8120*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		18" 90 deg elbow	$/EA	$ 3,100	1.32	$ 4,078.72	RS Means (2017)	*33.11.13.15.8140*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		20" 90 deg elbow	$/EA	$ 3,675	1.32	$ 4,835.26	RS Means (2017)	*33.11.13.15.8160*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		24" 90 deg elbow	$/EA	$ 5,350	1.32	$ 7,039.09	RS Means (2017)	*33.11.13.15.8180*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		4" tee or wye	$/EA	$ 635	1.32	$ 835.48	RS Means (2017)	*33.11.13.15.8200*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		6" tee or wye	$/EA	$ 895	1.32	$ 1,177.57	RS Means (2017)	*33.11.13.15.8220*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		8" tee or wye	$/EA	$ 1,300	1.32	$ 1,710.43	RS Means (2017)	*33.11.13.15.8240*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		10" tee or wye	$/EA	$ 1,750	1.32	$ 2,302.51	RS Means (2017)	*33.11.13.15.8260*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		12" tee or wye	$/EA	$ 2,375	1.32	$ 3,124.83	RS Means (2017)	*33.11.13.15.8280*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		14" tee or wye	$/EA	$ 3,550	1.32	$ 4,670.80	RS Means (2017)	*33.11.13.15.8300*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		16" tee or wye	$/EA	$ 4,075	1.32	$ 5,361.55	RS Means (2017)	*33.11.13.15.8320*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		8" cap	$/EA	$ 299	1.32	$ 393.40	RS Means (2017)	*33.11.13.15.6190*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		4" 45 deg elbow	$/EA	$ 425	1.32	$ 559.18	RS Means (2017)	*33.11.13.15.8398*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		6" 45 deg elbow	$/EA	$ 400	1.32	$ 526.29	RS Means (2017)	*33.11.13.15.8400*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		8" 45 deg elbow	$/EA	$ 540	1.32	$ 710.49	RS Means (2017)	*33.11.13.15.8405*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		10" 45 deg elbow	$/EA	$ 833	1.32	$ 1,095.33	interpolated		
Division 33 – Utilities	Fittings - DIP, AWWA C110		12" 45 deg elbow	$/EA	$ 1,125	1.32	$ 1,480.18	RS Means (2017)	*33.11.13.15.8410*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		16" 45 deg elbow	$/EA	$ 1,875	1.32	$ 2,466.97	RS Means (2017)	*33.11.13.15.8420*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		20" 45 deg elbow	$/EA	$ 2,875	1.32	$ 3,782.69	RS Means (2017)	*33.11.13.15.8430*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		24" 45 deg elbow	$/EA	$ 3,925	1.32	$ 5,164.19	RS Means (2017)	*33.11.13.15.8440*	
Division 33 – Utilities	HDPE		4" 90 deg elbow	$/EA	$ 130	1.32	$ 171.04	RS Means (2017)	*33.11.13.35.1200*	
Division 33 – Utilities	HDPE		6" 90 deg elbow	$/EA	$ 177	1.32	$ 232.88	RS Means (2017)	*33.11.13.35.1300*	
Division 33 – Utilities	HDPE		8" 90 deg elbow	$/EA	$ 278	1.32	$ 365.77	RS Means (2017)	*33.11.13.35.1400*	
Division 33 – Utilities	HDPE		10" 90 deg elbow	$/EA	$ 555	1.32	$ 730.22	RS Means (2017)	*33.11.13.35.1500*	
Division 33 – Utilities	HDPE		12" 90 deg elbow	$/EA	$ 670	1.32	$ 881.53	RS Means (2017)	*33.11.13.35.1600*	
Division 33 – Utilities	HDPE		14" 90 deg elbow	$/EA	$ 1,050	1.32	$ 1,381.50	RS Means (2017)	*33.11.13.35.1700*	
Division 33 – Utilities	HDPE		16" 90 deg elbow	$/EA	$ 1,375	1.32	$ 1,809.11	RS Means (2017)	*33.11.13.35.1800*	
Division 33 – Utilities	HDPE		18" 90 deg elbow	$/EA	$ 1,875	1.32	$ 2,466.97	RS Means (2017)	*33.11.13.35.1900*	
Division 33 – Utilities	HDPE		24" 90 deg elbow	$/EA	$ 2,625	1.32	$ 3,453.76	RS Means (2017)	*33.11.13.35.2000*	
Division 33 – Utilities	HDPE		4" tee	$/EA	$ 142	1.32	$ 186.83	RS Means (2017)	*33.11.13.35.2200*	
Division 33 – Utilities	HDPE		6" tee	$/EA	$ 194	1.32	$ 255.25	RS Means (2017)	*33.11.13.35.2300*	
Division 33 – Utilities	HDPE		8" tee	$/EA	$ 305	1.32	$ 401.29	RS Means (2017)	*33.11.13.35.2400*	
Division 33 – Utilities	HDPE		10" tee	$/EA	$ 430	1.32	$ 565.76	RS Means (2017)	*33.11.13.35.2500*	
Division 33 – Utilities	HDPE		12" tee	$/EA	$ 880	1.32	$ 1,157.83	RS Means (2017)	*33.11.13.35.2600*	
Division 33 – Utilities	HDPE		14" tee	$/EA	$ 1,250	1.32	$ 1,644.65	RS Means (2017)	*33.11.13.35.2700*	
Division 33 – Utilities	HDPE		16" tee	$/EA	$ 1,575	1.32	$ 2,072.25	RS Means (2017)	*33.11.13.35.2800*	
Division 33 – Utilities	HDPE		4" cap	$/EA	$ 121	1.32	$ 159.20	RS Means (2017)	*33.11.13.35.4110*	
Division 33 – Utilities	HDPE		6" cap	$/EA	$ 153	1.32	$ 201.30	RS Means (2017)	*33.11.13.35.4120*	
Division 33 – Utilities	HDPE		8" cap	$/EA	$ 194	1.32	$ 255.25	RS Means (2017)	*33.11.13.35.4130*	
Division 33 – Utilities	HDPE		10" cap	$/EA	$ 365	1.32	$ 480.24	RS Means (2017)	*33.11.13.35.4150*	
Division 33 – Utilities	HDPE		12" cap	$/EA	$ 480	1.32	$ 631.54	RS Means (2017)	*33.11.13.35.4160*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		4" 45 deg elbow	$/EA	$ 68	1.32	$ 88.81	RS Means (2017)	*33.11.13.25.8200*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		6" 45 deg elbow	$/EA	$ 107	1.32	$ 140.78	RS Means (2017)	*33.11.13.25.8220*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		8" 45 deg elbow	$/EA	$ 202	1.32	$ 265.77	RS Means (2017)	*33.11.13.25.8240*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		10" 45 deg elbow	$/EA	$ 375	1.32	$ 493.39	RS Means (2017)	*33.11.13.25.8260*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		12" 45 deg elbow	$/EA	$ 495	1.32	$ 651.28	RS Means (2017)	*33.11.13.25.8280*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		24" 45 deg elbow	$/EA	$ 990	1.32	$ 1,302.56	extrapolated		

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		4" 90 deg elbow	$/EA	$ 68	1.32	$ 88.81	RS Means (2017)	*33.11.13.25.8006*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		6" 90 deg elbow	$/EA	$ 110	1.32	$ 144.73	RS Means (2017)	*33.11.13.25.8020*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		8" 90 deg elbow	$/EA	$ 196	1.32	$ 257.88	RS Means (2017)	*33.11.13.25.8040*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		10" 90 deg elbow	$/EA	$ 440	1.32	$ 578.92	RS Means (2017)	*33.11.13.25.8060*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		12" 90 deg elbow	$/EA	$ 570	1.32	$ 749.96	RS Means (2017)	*33.11.13.25.8080*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		4" tee	$/EA	$ 89	1.32	$ 116.44	RS Means (2017)	*33.11.13.25.8100*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		6" tee	$/EA	$ 178	1.32	$ 234.20	RS Means (2017)	*33.11.13.25.8120*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		8" tee	$/EA	$ 248	1.32	$ 326.30	RS Means (2017)	*33.11.13.25.8140*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		10" tee	$/EA	$ 760	1.32	$ 999.95	RS Means (2017)	*33.11.13.25.8160*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		12" tee	$/EA	$ 1,025	1.32	$ 1,348.61	RS Means (2017)	*33.11.13.25.8180*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		4" tee	$/EA	$ 200	1.32	$ 263.14	RS Means (2017)	*22.11.13.48.4800*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		5" tee	$/EA	$ 385	1.32	$ 506.55	RS Means (2017)	*22.11.13.48.4810*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		6" tee	$/EA	$ 450	1.32	$ 592.07	RS Means (2017)	*22.11.13.48.4820*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		8" tee	$/EA	$ 860	1.32	$ 1,131.52	RS Means (2017)	*22.11.13.48.4830*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		12" tee	$/EA	$ 1,400	1.32	$ 1,842.00	RS Means (2017)	*22.11.13.48.4850*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		14" tee	$/EA	$ 1,500	1.32	$ 1,973.58	RS Means (2017)	*22.11.13.48.4851*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		16" tee	$/EA	$ 1,675	1.32	$ 2,203.83	RS Means (2017)	*22.11.13.48.4852*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		20" tee	$/EA	$ 2,900	1.32	$ 3,815.58	RS Means (2017)	*22.11.13.48.4854*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		24" tee	$/EA	$ 4,250	1.32	$ 5,591.80	RS Means (2017)	*22.11.13.48.4855*	
Division 02 – Site Construction	Demolition and Removal		Disposal (offsite)	$/CY	$ 19.20	1.32	$ 25.26	RS Means (2017)	*02.41.16.17.4250*	up to five miles away
Division 31 – Earthwork	Demolition and Removal		Offhaul, 8 C.Y. Truck	$/CY	$ 5.10	1.32	$ 6.71	RS Means (2017)	*31.23.23.20.0044*	8 CY truck, 25 mph ave., cycle 4 miles
Division 02 – Site Construction	Demolition and Removal		C&D Dumping and Hauling Fees	$/CY	$ 70.63	1.32	$ 93.37	RS Means / SF project (2016)		$55/cy fee from Redwood landfill. Fee is $45/ton if waste needs to comply with Marin County's recycling ordanance. If waste is 2 cy/ton fee would be $90/ton
Division 02 – Site Construction	Demolition and Removal		Patch Walls	$/SF	$ 1.50	1.32	$ 1.98	estimate		
Division 02 – Site Construction	Demolition and Removal		Concrete Slab	$/SF	$ 0.99	1.32	$ 1.30	RS Means (2017)	*02.41.16.17.0440*	
Division 02 – Site Construction	Demolition and Removal		Concrete Elevated Slab	$/CY	$ 35.50	1.32	$ 46.71	RS Means (2017)	*02.41.19.16.0050*	
Division 02 – Site Construction	Demolition and Removal		Concrete Wall	$/SF	$ 1.43	1.32	$ 1.88	RS Means (2017)	*02.41.16.17.2500*	12" thick
Division 02 – Site Construction	Demolition and Removal		Bituminous Pavement Removal	$/SY	$ 9.80	1.32	$ 12.89	RS Means (2017)	*02.41.13.17.5050*	
Division 02 – Site Construction	Demolition and Removal		Concrete Pavement Removal	$/SY	$ 16.15	1.32	$ 21.25	RS Means (2017)	*02.41.13.17.5200*	
Division 02 – Site Construction	Demolition and Removal		Concrete Curb Removal	$/LF	$ 7.20	1.32	$ 9.47	RS Means (2017)	*02.41.13.17.6100*	
Division 02 – Site Construction	Demolition and Removal		Building Demolition	$/SF of floor	$ 2.78	1.32	$ 3.66	RS Means (2017)	*13.05.05.50.0550*	
Division 02 – Site Construction	Demolition and Removal		Steel Tank Demo, 275 gal	$/EA	$ 450	1.32	$ 592.07	RS Means (2017)	*13.05.05.75.0510*	
Division 02 – Site Construction	Demolition and Removal		Steel Tank Demo, 550-2200 gal	$/EA	$ 1,325	1.32	$ 1,743.33	RS Means (2017)	*13.05.05.75.0520*	
Division 02 – Site Construction	Demolition and Removal		Steel Tank Demo, 5000-10000 gal	$/EA	$ 1,625	1.32	$ 2,138.04	RS Means (2017)	*13.05.05.75.0530*	
Division 02 – Site Construction	Demolition and Removal		Steel Tank Demo, 15000-30000 gal	$/EA	$ 3,250	1.32	$ 4,276.08	RS Means (2017)	*13.05.05.75.0540*	
Division 02 – Site Construction	Demolition and Removal		Piping, 4"-6"	$/LF	$ 14.90	1.32	$ 19.60	RS Means (2017)	*22.05.05.10.2100*	
Division 02 – Site Construction	Demolition and Removal		Piping, 8"-14"	$/LF	$ 25.00	1.32	$ 32.89	RS Means (2017)	*22.05.05.10.2150*	
Division 02 – Site Construction	Demolition and Removal		Piping, 16"-20"	$/LF	$ 31.00	1.32	$ 40.79	RS Means (2017)	*22.05.05.10.2153*	
Division 02 – Site Construction	Demolition and Removal		Piping, 24"-26"	$/LF	$ 39.50	1.32	$ 51.97	RS Means (2017)	*22.05.05.10.2155*	
Division 02 – Site Construction	Demolition and Removal		Piping, 30"-36"	$/LF	$ 54.00	1.32	$ 71.05	RS Means (2017)	*22.05.05.10.2156*	
Division 02 – Site Construction	Demolition and Removal		Ductwork, 30" H, 26" W	$/LF	$ 8.55	1.32	$ 11.25	RS Means (2017)	*23.05.05.10.1500*	
Division 31 – Earthwork	Dewatering			$/DAY	$ 1,091	1.00	$ 1,091.22	RS Means (2019) - raw unit costs have location factor embedded in it	31.23.19.20.1000	8 hours with 4" diaphragm pump, labor included
Division 31 – Earthwork	Dewatering			$/DAY	$ 272.81	1.32	$ 358.93	RS Means (2017)	31.23.19.20.1020	Add 2 additional pumps
Division 31 – Earthwork	Dewatering			$/DAY	$ 4,092	1.03	$ 4,204.60	RMC, not identified (2017)		Total for 24 hours, 3 pumps
Division 31 – Earthwork	Microtunneling			$/inch-diam per LF of casing	$ 48.00	1.03	$ 49.32	RMC, not identified (2017)		
Division 31 – Earthwork	Microtunneling		Launch Shaft		$ 300,000	1.03	$ 308,249.42	RMC, not identified (2017)		
Division 31 – Earthwork	Microtunneling		Reception Shaft		$ 150,000	1.03	$ 154,124.71	RMC, not identified (2017)		

Exhibit 2: R&R Values Used from Valley Water

This exhibit provides a list of the R&R values used from the v.65 export of Valley Water's asset management database. As requested by Valley Water, the "cell reference" column indicates the location of the cell in the exported file, and the "ID" column indicates the relevant asset's ID.

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Exhibit 2

Exhibit 2: Asset Types, Classes, and R&R Basis

Asset Class ID	Asset Type	Asset Class	Replacement Cycle (Years)	Renewal Cycle (Years)	Renewal Costs (Percent)	Valley Water Asset ID	Basis of Recommendation
AC 1	Site Improv	Roadways and Walkways	75	30	25%	L17	Replacement - Valley Water asset database; Renewal - Expedited Purified Water Program
AC 2	Site Improv	Metals and Fencing	75	0	0%	L12	Valley Water asset database
AC 3	Earthwork	Subgrade Structural Piles	70	30	25%		Expedited Purified Water Program
AC 4	Concrete	Above/Below Grade (slabs, pads, vaults, etc.)	100	25	25%		Expedited Purified Water Program
AC 5	Equipment	Pumps, Chemical metering	10	0	0%	PU21	Valley Water asset database
AC 6	Equipment	Pumps, Process/Product, 25-50 HP submersible	15	0	0%	PU25	Valley Water asset database
AC 7	Equipment	Pumps, Process/Product, 25-75 HP	20	10	30%	PU12	Replacement - Valley Water asset databaseRenewal - Expedited Purified Water Program
AC 8	Equipment	Pumps, Process/Product, 100-200 HP	30	15	30%	PU14	Valley Water asset database
AC 9	Equipment	Flow Meters	10	0	0%	FE7	Valley Water asset database
AC 10	Equipment	Static Mixers	40	0	0%	MX5	Valley Water asset database
AC 11	Equipment	Tanks, Process (steel)	50	20	30%		Expedited Purified Water Program
AC 12	Equipment	Ozone system	50	25	75%		Engineer's Estimate
AC 13	Equipment	Biologically activated carbon (BAC) system	50	25	75%		Engineer's Estimate
AC 14	Equipment	UF system	50	25	75%		Engineer's Estimate
AC 15	Equipment	RO System	50	25	75%		Engineer's Estimate
AC 16	Equipment	Decarbonator System	40	20	20%		Expedited Purified Water Program
AC 17	Equipment	UV System	50	25	75%		Engineer's Estimate
AC 18	Structures/	Process Building (prefabricated steel, single story)	75	0	0%	BU3	Valley Water asset database
AC 19	Structures/	Canopies, Steel	75	0	0%		Expedited Purified Water Program
AC 20	Chemical Ta	Tanks, Chemical (carbon steel, vertical)	40	8	20%	TK22	Replacement - Valley Water asset databaseRenewal - Expedited Purified Water Program
AC 21	Chemical Ta	Tanks, Chemical (fiberglass reinforced plastic, vertical)	25	8	20%		Expedited Purified Water Program
AC 22	Chemical Ta	Tanks, Chemical (high-density polyethylene, vertical)	25	8	20%		Expedited Purified Water Program
AC 23	Mechanical	Piping, Conveyance	100	20	4%		Expedited Purified Water Program
AC 24	Mechanical	Piping, Process (stainless steel or equivalent)	100	0	0%		Replacement - Expedited Purified Water Program; Renewal - Standard industry sources
AC 25	Mechanical	Valves	30	0	0%		Expedited Purified Water Program
AC 26	Electrical	Electrical Equipment and Accessories	25	0	0%	CP6	Valley Water asset database
AC 27	Instrumenta	Instrumentation (except flow meters)	20	0	0%		Expedited Purified Water Program
AC 28	N/A	NO CAPITAL/R&R COST	0	0	0%		
AC 29	Equipment	Pumps, Process/Product, >200 HP	50	25	30%	PU6	Valley Water asset database
AC 30	Equipment	MBR System	50	25	75%		Engineer's Estimate
AC 31	Concrete	Concrete water tank	100	20	1%	TK 39	DN Tanks vendor proposal

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Appendix A-6: Cost Estimates

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Lifecycle Costs

Table 1-1. Life-cycle cost for Portfolio 1a

Portfolio 1a

Summary of Lifecycle Unit Costs ($/AF)							
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only	Unit Costs, including ROC management	
	Upper Bound Yield Estimate	Lower Bound Yield Estimate	Upper Bound Yield Estimate	Lower Bound Yield Estimate		Upper Bound Yield Estimate	Lower Bound Yield Estimate
100-Yr Lifecycle:	$ 1,800	$ 2,300	$ 1,500	$ 1,900	$ 200	$ 2,000	$ 2,500
30-Yr Lifecycle:	$ 2,300	$ 2,900	$ 2,100	$ 2,700	$ 200	$ 2,500	$ 3,100

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	**$630,000,000**	**$1,840,000,000**	**$1,045,000,000**	**$3,515,000,000**	**$1,320,000,000**	**2,400,000**	**742,000**	**1,900,000**	**587,000**
	30-Yr Lifecycle:	**$630,000,000**	**$555,000,000**	**$190,000,000**	**$1,370,000,000**	**$950,000,000**	**720,000**	**419,000**	**570,000**	**331,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$157,500,000		$0	$157,500,000	$139,702,566				
2025		$157,500,000		$0	$157,500,000	$136,392,079				
2026		$157,500,000		$0	$157,500,000	$133,160,039				
2027		$157,500,000		$0	$157,500,000	$130,004,588				
2028	Year 1		$18,400,000	$0	$18,400,000	$14,827,936	24,000	19,341	19,000	15,311
2029	Year 2		$18,400,000	$0	$18,400,000	$14,476,563	24,000	18,882	19,000	14,949
2030	Year 3		$18,400,000	$0	$18,400,000	$14,133,517	24,000	18,435	19,000	14,594
2031	Year 4		$18,400,000	$0	$18,400,000	$13,798,599	24,000	17,998	19,000	14,249
2032	Year 5		$18,400,000	$0	$18,400,000	$13,471,618	24,000	17,572	19,000	13,911
2033	Year 6		$18,400,000	$0	$18,400,000	$13,152,386	24,000	17,155	19,000	13,581
2034	Year 7		$18,400,000	$0	$18,400,000	$12,840,718	24,000	16,749	19,000	13,259
2035	Year 8		$18,400,000	$487,364	$18,887,364	$12,868,490	24,000	16,352	19,000	12,945
2036	Year 9		$18,400,000	$0	$18,400,000	$12,239,363	24,000	15,964	19,000	12,638
2037	Year 10		$18,400,000	$2,394,091	$20,794,091	$13,504,102	24,000	15,586	19,000	12,339
2038	Year 11		$18,400,000	$0	$18,400,000	$11,666,172	24,000	15,217	19,000	12,047
2039	Year 12		$18,400,000	$0	$18,400,000	$11,389,722	24,000	14,856	19,000	11,761
2040	Year 13		$18,400,000	$0	$18,400,000	$11,119,823	24,000	14,504	19,000	11,482
2041	Year 14		$18,400,000	$0	$18,400,000	$10,856,320	24,000	14,160	19,000	11,210
2042	Year 15		$18,400,000	$2,184,046	$20,584,046	$11,857,151	24,000	13,825	19,000	10,945
2043	Year 16		$18,400,000	$487,364	$18,887,364	$10,621,986	24,000	13,497	19,000	10,685
2044	Year 17		$18,400,000	$0	$18,400,000	$10,102,688	24,000	13,177	19,000	10,432

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2045	Year 18		$18,400,000	$0	$18,400,000	$9,863,288	24,000	12,865	19,000	10,185
2046	Year 19		$18,400,000	$0	$18,400,000	$9,629,561	24,000	12,560	19,000	9,944
2047	Year 20		$18,400,000	$25,476,697	$43,876,697	$22,418,541	24,000	12,263	19,000	9,708
2048	Year 21		$18,400,000	$0	$18,400,000	$9,178,591	24,000	11,972	19,000	9,478
2049	Year 22		$18,400,000	$0	$18,400,000	$8,961,089	24,000	11,688	19,000	9,253
2050	Year 23		$18,400,000	$0	$18,400,000	$8,748,741	24,000	11,411	19,000	9,034
2051	Year 24		$18,400,000	$487,364	$18,887,364	$8,767,663	24,000	11,141	19,000	8,820
2052	Year 25		$18,400,000	$145,003,372	$163,403,372	$74,055,661	24,000	10,877	19,000	8,611
2053	Year 26		$18,400,000	$0	$18,400,000	$8,141,414	24,000	10,619	19,000	8,407
2054	Year 27		$18,400,000	$0	$18,400,000	$7,948,489	24,000	10,368	19,000	8,208
2055	Year 28		$18,400,000	$0	$18,400,000	$7,760,137	24,000	10,122	19,000	8,013
2056	Year 29		$18,400,000	$0	$18,400,000	$7,576,247	24,000	9,882	19,000	7,823
2057	Year 30		$18,400,000	$9,610,966	$28,010,966	$11,260,279	24,000	9,648	19,000	7,638
2058	Year 31		$18,400,000	$0	$18,400,000	$7,221,438	24,000	9,419	19,000	7,457
2059	Year 32		$18,400,000	$148,175	$18,548,175	$7,107,090	24,000	9,196	19,000	7,280
2060	Year 33		$18,400,000	$339,189	$18,739,189	$7,010,131	24,000	8,978	19,000	7,108
2061	Year 34		$18,400,000	$0	$18,400,000	$6,720,134	24,000	8,765	19,000	6,939
2062	Year 35		$18,400,000	$0	$18,400,000	$6,560,889	24,000	8,558	19,000	6,775
2063	Year 36		$18,400,000	$0	$18,400,000	$6,405,418	24,000	8,355	19,000	6,614
2064	Year 37		$18,400,000	$0	$18,400,000	$6,253,631	24,000	8,157	19,000	6,458
2065	Year 38		$18,400,000	$0	$18,400,000	$6,105,441	24,000	7,964	19,000	6,305
2066	Year 39		$18,400,000	$0	$18,400,000	$5,960,762	24,000	7,775	19,000	6,155
2067	Year 40		$18,400,000	$29,394,609	$47,794,609	$15,116,374	24,000	7,591	19,000	6,009
2068	Year 41		$18,400,000	$339,189	$18,739,189	$5,786,344	24,000	7,411	19,000	5,867
2069	Year 42		$18,400,000	$0	$18,400,000	$5,546,973	24,000	7,235	19,000	5,728
2070	Year 43		$18,400,000	$0	$18,400,000	$5,415,528	24,000	7,064	19,000	5,592
2071	Year 44		$18,400,000	$0	$18,400,000	$5,287,198	24,000	6,896	19,000	5,460
2072	Year 45		$18,400,000	$2,184,046	$20,584,046	$5,774,618	24,000	6,733	19,000	5,330
2073	Year 46		$18,400,000	$0	$18,400,000	$5,039,589	24,000	6,573	19,000	5,204
2074	Year 47		$18,400,000	$0	$18,400,000	$4,920,168	24,000	6,418	19,000	5,081
2075	Year 48		$18,400,000	$148,175	$18,548,175	$4,842,259	24,000	6,266	19,000	4,960
2076	Year 49		$18,400,000	$339,189	$18,739,189	$4,776,199	24,000	6,117	19,000	4,843
2077	Year 50		$18,400,000	$178,792,977	$197,192,977	$49,069,069	24,000	5,972	19,000	4,728
2078	Year 51		$18,400,000	$0	$18,400,000	$4,470,118	24,000	5,831	19,000	4,616
2079	Year 52		$18,400,000	$0	$18,400,000	$4,364,191	24,000	5,692	19,000	4,507
2080	Year 53		$18,400,000	$0	$18,400,000	$4,260,774	24,000	5,558	19,000	4,400
2081	Year 54		$18,400,000	$0	$18,400,000	$4,159,808	24,000	5,426	19,000	4,295
2082	Year 55		$18,400,000	$0	$18,400,000	$4,061,234	24,000	5,297	19,000	4,194
2083	Year 56		$18,400,000	$148,175	$18,548,175	$3,996,926	24,000	5,172	19,000	4,094
2084	Year 57		$18,400,000	$0	$18,400,000	$3,871,039	24,000	5,049	19,000	3,997
2085	Year 58		$18,400,000	$339,189	$18,739,189	$3,848,977	24,000	4,930	19,000	3,903
2086	Year 59		$18,400,000	$0	$18,400,000	$3,689,751	24,000	4,813	19,000	3,810
2087	Year 60		$18,400,000	$32,213,032	$50,613,032	$9,908,921	24,000	4,699	19,000	3,720
2088	Year 61		$18,400,000	$6,197	$18,406,197	$3,518,138	24,000	4,587	19,000	3,632

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2089	Year 62		$18,400,000	$9,106	$18,409,106	$3,435,313	24,000	4,479	19,000	3,546
2090	Year 63		$18,400,000	$13,251	$18,413,251	$3,354,662	24,000	4,372	19,000	3,462
2091	Year 64		$18,400,000	$167,262	$18,567,262	$3,302,562	24,000	4,269	19,000	3,380
2092	Year 65		$18,400,000	$27,222	$18,427,222	$3,199,983	24,000	4,168	19,000	3,299
2093	Year 66		$18,400,000	$377,627	$18,777,627	$3,183,562	24,000	4,069	19,000	3,221
2094	Year 67		$18,400,000	$53,734	$18,453,734	$3,054,511	24,000	3,973	19,000	3,145
2095	Year 68		$18,400,000	$74,370	$18,474,370	$2,985,464	24,000	3,878	19,000	3,070
2096	Year 69		$18,400,000	$101,907	$18,501,907	$2,919,063	24,000	3,787	19,000	2,998
2097	Year 70		$18,400,000	$3,920,930	$22,320,930	$3,438,143	24,000	3,697	19,000	2,927
2098	Year 71		$18,400,000	$185,685	$18,585,685	$2,794,956	24,000	3,609	19,000	2,857
2099	Year 72		$18,400,000	$395,092	$18,795,092	$2,759,470	24,000	3,524	19,000	2,790
2100	Year 73		$18,400,000	$325,074	$18,725,074	$2,684,043	24,000	3,440	19,000	2,723
2101	Year 74		$18,400,000	$762,899	$19,162,899	$2,681,711	24,000	3,359	19,000	2,659
2102	Year 75		$18,400,000	$201,149,792	$219,549,792	$29,996,358	24,000	3,279	19,000	2,596
2103	Year 76		$18,400,000	$698,580	$19,098,580	$2,547,542	24,000	3,201	19,000	2,534
2104	Year 77		$18,400,000	$883,642	$19,283,642	$2,511,274	24,000	3,125	19,000	2,474
2105	Year 78		$18,400,000	$1,106,607	$19,506,607	$2,480,113	24,000	3,051	19,000	2,416
2106	Year 79		$18,400,000	$1,372,038	$19,772,038	$2,454,291	24,000	2,979	19,000	2,358
2107	Year 80		$18,400,000	$30,594,107	$48,994,107	$5,937,494	24,000	2,909	19,000	2,303
2108	Year 81		$18,400,000	$2,046,839	$20,446,839	$2,419,192	24,000	2,840	19,000	2,248
2109	Year 82		$18,400,000	$2,462,797	$20,862,797	$2,409,913	24,000	2,772	19,000	2,195
2110	Year 83		$18,400,000	$3,272,984	$21,672,984	$2,444,175	24,000	2,707	19,000	2,143
2111	Year 84		$18,400,000	$3,460,100	$21,860,100	$2,406,858	24,000	2,642	19,000	2,092
2112	Year 85		$18,400,000	$4,040,212	$22,440,212	$2,412,182	24,000	2,580	19,000	2,042
2113	Year 86		$18,400,000	$4,670,646	$23,070,646	$2,421,183	24,000	2,519	19,000	1,994
2114	Year 87		$18,400,000	$5,345,725	$23,745,725	$2,432,978	24,000	2,459	19,000	1,947
2115	Year 88		$18,400,000	$6,205,675	$24,605,675	$2,461,346	24,000	2,401	19,000	1,901
2116	Year 89		$18,400,000	$6,795,749	$25,195,749	$2,460,648	24,000	2,344	19,000	1,856
2117	Year 90		$18,400,000	$16,921,952	$35,321,952	$3,367,842	24,000	2,288	19,000	1,812
2118	Year 91		$18,400,000	$8,639,534	$27,039,534	$2,517,045	24,000	2,234	19,000	1,769
2119	Year 92		$18,400,000	$9,036,728	$27,436,728	$2,493,497	24,000	2,181	19,000	1,727
2120	Year 93		$18,400,000	$9,740,546	$28,140,546	$2,496,858	24,000	2,129	19,000	1,686
2121	Year 94		$18,400,000	$10,394,711	$28,794,711	$2,494,358	24,000	2,079	19,000	1,646
2122	Year 95		$18,400,000	$10,982,434	$29,382,434	$2,484,955	24,000	2,030	19,000	1,607
2123	Year 96		$18,400,000	$11,636,107	$30,036,107	$2,480,043	24,000	1,982	19,000	1,569
2124	Year 97		$18,400,000	$11,897,129	$30,297,129	$2,442,316	24,000	1,935	19,000	1,532
2125	Year 98		$18,400,000	$12,198,306	$30,598,306	$2,408,144	24,000	1,889	19,000	1,495
2126	Year 99		$18,400,000	$12,721,849	$31,121,849	$2,391,307	24,000	1,844	19,000	1,460
2127	Year 100		$18,400,000	$216,451,108	$234,851,108	$17,617,620	24,000	1,800	19,000	1,425

[1] ROCM lifecycle costs are placeholders based on the values reported in "Task 5 - Basis of Cost Estimated for ROCM Options FINAL (3-6-20)"by GHD, deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Table 1-2. Life-cycle cost for Portfolio 1b

Portfolio 1b

Summary of Lifecycle Unit Costs ($/AF)							
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only	Unit Costs, including ROC management	
	Upper Bound Yield Estimate	Lower Bound Yield Estimate	Upper Bound Yield Estimate	Lower Bound Yield Estimate		Upper Bound Yield Estimate	Lower Bound Yield Estimate
100-Yr Lifecycle:	$ 1,900	$ 2,300	$ 1,500	$ 1,900	$ 200	$ 2,100	$ 2,500
30-Yr Lifecycle:	$ 2,400	$ 2,800	$ 2,100	$ 2,500	$ 200	$ 2,600	$ 3,000

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	**$615,000,000**	**$1,890,000,000**	**$1,185,000,000**	**$3,690,000,000**	**$1,360,000,000**	**2,400,000**	**742,000**	**1,980,000**	**612,000**
	30-Yr Lifecycle:	**$615,000,000**	**$570,000,000**	**$235,000,000**	**$1,415,000,000**	**$965,000,000**	**720,000**	**419,000**	**594,000**	**345,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$153,750,000		$0	$153,750,000	$136,376,315				
2025		$153,750,000		$0	$153,750,000	$133,144,648				
2026		$153,750,000		$0	$153,750,000	$129,989,562				
2027		$153,750,000		$0	$153,750,000	$126,909,240				
2028	Year 1		$18,900,000	$0	$18,900,000	$15,230,869	24,000	19,341	19,800	15,956
2029	Year 2		$18,900,000	$0	$18,900,000	$14,869,948	24,000	18,882	19,800	15,578
2030	Year 3		$18,900,000	$0	$18,900,000	$14,517,580	24,000	18,435	19,800	15,209
2031	Year 4		$18,900,000	$0	$18,900,000	$14,173,561	24,000	17,998	19,800	14,848
2032	Year 5		$18,900,000	$0	$18,900,000	$13,837,695	24,000	17,572	19,800	14,497
2033	Year 6		$18,900,000	$0	$18,900,000	$13,509,787	24,000	17,155	19,800	14,153
2034	Year 7		$18,900,000	$0	$18,900,000	$13,189,650	24,000	16,749	19,800	13,818
2035	Year 8		$18,900,000	$494,691	$19,394,691	$13,214,146	24,000	16,352	19,800	13,490
2036	Year 9		$18,900,000	$0	$18,900,000	$12,571,955	24,000	15,964	19,800	13,171
2037	Year 10		$18,900,000	$4,132,508	$23,032,508	$14,957,775	24,000	15,586	19,800	12,859
2038	Year 11		$18,900,000	$0	$18,900,000	$11,983,187	24,000	15,217	19,800	12,554
2039	Year 12		$18,900,000	$0	$18,900,000	$11,699,225	24,000	14,856	19,800	12,256
2040	Year 13		$18,900,000	$0	$18,900,000	$11,421,993	24,000	14,504	19,800	11,966
2041	Year 14		$18,900,000	$0	$18,900,000	$11,151,329	24,000	14,160	19,800	11,682
2042	Year 15		$18,900,000	$2,184,046	$21,084,046	$12,145,169	24,000	13,825	19,800	11,406
2043	Year 16		$18,900,000	$494,691	$19,394,691	$10,907,299	24,000	13,497	19,800	11,135

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2044	Year 17		$18,900,000	$0	$18,900,000	$10,377,218	24,000	13,177	19,800	10,871
2045	Year 18		$18,900,000	$0	$18,900,000	$10,131,312	24,000	12,865	19,800	10,614
2046	Year 19		$18,900,000	$0	$18,900,000	$9,891,234	24,000	12,560	19,800	10,362
2047	Year 20		$18,900,000	$24,941,651	$43,841,651	$22,400,635	24,000	12,263	19,800	10,117
2048	Year 21		$18,900,000	$0	$18,900,000	$9,428,009	24,000	11,972	19,800	9,877
2049	Year 22		$18,900,000	$0	$18,900,000	$9,204,597	24,000	11,688	19,800	9,643
2050	Year 23		$18,900,000	$0	$18,900,000	$8,986,478	24,000	11,411	19,800	9,414
2051	Year 24		$18,900,000	$494,691	$19,394,691	$9,003,168	24,000	11,141	19,800	9,191
2052	Year 25		$18,900,000	$184,737,148	$203,637,148	$92,289,917	24,000	10,877	19,800	8,974
2053	Year 26		$18,900,000	$0	$18,900,000	$8,362,648	24,000	10,619	19,800	8,761
2054	Year 27		$18,900,000	$0	$18,900,000	$8,164,481	24,000	10,368	19,800	8,553
2055	Year 28		$18,900,000	$0	$18,900,000	$7,971,010	24,000	10,122	19,800	8,351
2056	Year 29		$18,900,000	$0	$18,900,000	$7,782,123	24,000	9,882	19,800	8,153
2057	Year 30		$18,900,000	$12,690,010	$31,590,010	$12,699,038	24,000	9,648	19,800	7,960
2058	Year 31		$18,900,000	$0	$18,900,000	$7,417,672	24,000	9,419	19,800	7,771
2059	Year 32		$18,900,000	$148,175	$19,048,175	$7,298,674	24,000	9,196	19,800	7,587
2060	Year 33		$18,900,000	$346,516	$19,246,516	$7,199,917	24,000	8,978	19,800	7,407
2061	Year 34		$18,900,000	$0	$18,900,000	$6,902,747	24,000	8,765	19,800	7,231
2062	Year 35		$18,900,000	$0	$18,900,000	$6,739,175	24,000	8,558	19,800	7,060
2063	Year 36		$18,900,000	$0	$18,900,000	$6,579,478	24,000	8,355	19,800	6,893
2064	Year 37		$18,900,000	$0	$18,900,000	$6,423,567	24,000	8,157	19,800	6,729
2065	Year 38		$18,900,000	$0	$18,900,000	$6,271,349	24,000	7,964	19,800	6,570
2066	Year 39		$18,900,000	$0	$18,900,000	$6,122,739	24,000	7,775	19,800	6,414
2067	Year 40		$18,900,000	$28,859,563	$47,759,563	$15,105,290	24,000	7,591	19,800	6,262
2068	Year 41		$18,900,000	$346,516	$19,246,516	$5,942,998	24,000	7,411	19,800	6,114
2069	Year 42		$18,900,000	$0	$18,900,000	$5,697,706	24,000	7,235	19,800	5,969
2070	Year 43		$18,900,000	$0	$18,900,000	$5,562,690	24,000	7,064	19,800	5,828
2071	Year 44		$18,900,000	$0	$18,900,000	$5,430,872	24,000	6,896	19,800	5,689
2072	Year 45		$18,900,000	$2,184,046	$21,084,046	$5,914,888	24,000	6,733	19,800	5,555
2073	Year 46		$18,900,000	$0	$18,900,000	$5,176,535	24,000	6,573	19,800	5,423
2074	Year 47		$18,900,000	$0	$18,900,000	$5,053,868	24,000	6,418	19,800	5,295
2075	Year 48		$18,900,000	$148,175	$19,048,175	$4,972,791	24,000	6,266	19,800	5,169
2076	Year 49		$18,900,000	$346,516	$19,246,516	$4,905,505	24,000	6,117	19,800	5,047
2077	Year 50		$18,900,000	$229,916,180	$248,816,180	$61,914,874	24,000	5,972	19,800	4,927
2078	Year 51		$18,900,000	$0	$18,900,000	$4,591,588	24,000	5,831	19,800	4,810
2079	Year 52		$18,900,000	$0	$18,900,000	$4,482,783	24,000	5,692	19,800	4,696
2080	Year 53		$18,900,000	$0	$18,900,000	$4,376,556	24,000	5,558	19,800	4,585
2081	Year 54		$18,900,000	$0	$18,900,000	$4,272,846	24,000	5,426	19,800	4,476
2082	Year 55		$18,900,000	$0	$18,900,000	$4,171,594	24,000	5,297	19,800	4,370
2083	Year 56		$18,900,000	$148,175	$19,048,175	$4,104,671	24,000	5,172	19,800	4,267
2084	Year 57		$18,900,000	$0	$18,900,000	$3,976,230	24,000	5,049	19,800	4,166
2085	Year 58		$18,900,000	$346,516	$19,246,516	$3,953,180	24,000	4,930	19,800	4,067
2086	Year 59		$18,900,000	$0	$18,900,000	$3,790,016	24,000	4,813	19,800	3,970

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2087	Year 60		$18,900,000	$33,017,151	$51,917,151	$10,164,239	24,000	4,699	19,800	3,876
2088	Year 61		$18,900,000	$4,026	$18,904,026	$3,613,292	24,000	4,587	19,800	3,785
2089	Year 62		$18,900,000	$5,916	$18,905,916	$3,528,022	24,000	4,479	19,800	3,695
2090	Year 63		$18,900,000	$8,611	$18,908,611	$3,444,911	24,000	4,372	19,800	3,607
2091	Year 64		$18,900,000	$160,576	$19,060,576	$3,390,308	24,000	4,269	19,800	3,522
2092	Year 65		$18,900,000	$17,687	$18,917,687	$3,285,155	24,000	4,168	19,800	3,438
2093	Year 66		$18,900,000	$371,489	$19,271,489	$3,267,292	24,000	4,069	19,800	3,357
2094	Year 67		$18,900,000	$34,912	$18,934,912	$3,134,156	24,000	3,973	19,800	3,277
2095	Year 68		$18,900,000	$48,319	$18,948,319	$3,062,054	24,000	3,878	19,800	3,200
2096	Year 69		$18,900,000	$66,210	$18,966,210	$2,992,316	24,000	3,787	19,800	3,124
2097	Year 70		$18,900,000	$5,610,919	$24,510,919	$3,775,472	24,000	3,697	19,800	3,050
2098	Year 71		$18,900,000	$120,641	$19,020,641	$2,860,366	24,000	3,609	19,800	2,978
2099	Year 72		$18,900,000	$308,599	$19,208,599	$2,820,180	24,000	3,524	19,800	2,907
2100	Year 73		$18,900,000	$211,205	$19,111,205	$2,739,391	24,000	3,440	19,800	2,838
2101	Year 74		$18,900,000	$621,805	$19,521,805	$2,731,937	24,000	3,359	19,800	2,771
2102	Year 75		$18,900,000	$242,108,655	$261,008,655	$35,660,745	24,000	3,279	19,800	2,705
2103	Year 76		$18,900,000	$453,875	$19,353,875	$2,581,596	24,000	3,201	19,800	2,641
2104	Year 77		$18,900,000	$574,112	$19,474,112	$2,536,079	24,000	3,125	19,800	2,579
2105	Year 78		$18,900,000	$718,974	$19,618,974	$2,494,400	24,000	3,051	19,800	2,517
2106	Year 79		$18,900,000	$891,428	$19,791,428	$2,456,698	24,000	2,979	19,800	2,458
2107	Year 80		$18,900,000	$29,469,099	$48,369,099	$5,861,750	24,000	2,909	19,800	2,400
2108	Year 81		$18,900,000	$1,329,852	$20,229,852	$2,393,519	24,000	2,840	19,800	2,343
2109	Year 82		$18,900,000	$1,600,104	$20,500,104	$2,368,018	24,000	2,772	19,800	2,287
2110	Year 83		$18,900,000	$2,252,633	$21,152,633	$2,385,493	24,000	2,707	19,800	2,233
2111	Year 84		$18,900,000	$2,248,062	$21,148,062	$2,328,461	24,000	2,642	19,800	2,180
2112	Year 85		$18,900,000	$2,624,967	$21,524,967	$2,313,799	24,000	2,580	19,800	2,128
2113	Year 86		$18,900,000	$3,034,566	$21,934,566	$2,301,956	24,000	2,519	19,800	2,078
2114	Year 87		$18,900,000	$3,473,171	$22,373,171	$2,292,346	24,000	2,459	19,800	2,029
2115	Year 88		$18,900,000	$4,083,795	$22,983,795	$2,299,107	24,000	2,401	19,800	1,981
2116	Year 89		$18,900,000	$4,415,267	$23,315,267	$2,276,998	24,000	2,344	19,800	1,934
2117	Year 90		$18,900,000	$17,274,410	$36,174,410	$3,449,121	24,000	2,288	19,800	1,888
2118	Year 91		$18,900,000	$5,739,335	$24,639,335	$2,293,616	24,000	2,234	19,800	1,843
2119	Year 92		$18,900,000	$5,871,255	$24,771,255	$2,251,254	24,000	2,181	19,800	1,799
2120	Year 93		$18,900,000	$6,328,532	$25,228,532	$2,238,480	24,000	2,129	19,800	1,757
2121	Year 94		$18,900,000	$6,753,550	$25,653,550	$2,222,253	24,000	2,079	19,800	1,715
2122	Year 95		$18,900,000	$7,135,398	$26,035,398	$2,201,887	24,000	2,030	19,800	1,675
2123	Year 96		$18,900,000	$7,612,001	$26,512,001	$2,189,062	24,000	1,982	19,800	1,635
2124	Year 97		$18,900,000	$7,729,685	$26,629,685	$2,146,675	24,000	1,935	19,800	1,596
2125	Year 98		$18,900,000	$7,925,363	$26,825,363	$2,111,206	24,000	1,889	19,800	1,558
2126	Year 99		$18,900,000	$8,391,655	$27,291,655	$2,097,006	24,000	1,844	19,800	1,521
2127	Year 100		$18,900,000	$270,052,362	$288,952,362	$21,676,087	24,000	1,800	19,800	1,485

Table 1-3. Life-cycle cost for Portfolio 1c

Portfolio 1c

Summary of Lifecycle Unit Costs ($/AF)							
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only	Unit Costs, including ROC management	
	Upper Bound Yield Estimate	Lower Bound Yield Estimate	Upper Bound Yield Estimate	Lower Bound Yield Estimate		Upper Bound Yield Estimate	Lower Bound Yield Estimate
100-Yr Lifecycle:	$ 1,900	$ 1,900	$ 1,600	$ 1,600	$ 200	$ 2,100	$ 2,100
30-Yr Lifecycle:	$ 2,300	$ 2,300	$ 2,000	$ 2,000	$ 200	$ 2,500	$ 2,500

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	**$535,000,000**	**$2,140,000,000**	**$1,165,000,000**	**$3,840,000,000**	**$1,365,000,000**	**2,400,000**	**742,000**	**2,400,000**	**742,000**
	30-Yr Lifecycle:	**$535,000,000**	**$645,000,000**	**$230,000,000**	**$1,405,000,000**	**$940,000,000**	**720,000**	**419,000**	**720,000**	**419,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$133,750,000		$0	$133,750,000	$118,636,306				
2025		$133,750,000		$0	$133,750,000	$115,825,019				
2026		$133,750,000		$0	$133,750,000	$113,080,351				
2027		$133,750,000		$0	$133,750,000	$110,400,721				
2028	Year 1		$21,400,000	$0	$21,400,000	$17,245,534	24,000	19,341	24,000	19,341
2029	Year 2		$21,400,000	$0	$21,400,000	$16,836,873	24,000	18,882	24,000	18,882
2030	Year 3		$21,400,000	$0	$21,400,000	$16,437,895	24,000	18,435	24,000	18,435
2031	Year 4		$21,400,000	$0	$21,400,000	$16,048,371	24,000	17,998	24,000	17,998
2032	Year 5		$21,400,000	$0	$21,400,000	$15,668,078	24,000	17,572	24,000	17,572
2033	Year 6		$21,400,000	$0	$21,400,000	$15,296,796	24,000	17,155	24,000	17,155
2034	Year 7		$21,400,000	$0	$21,400,000	$14,934,313	24,000	16,749	24,000	16,749
2035	Year 8		$21,400,000	$665,185	$22,065,185	$15,033,629	24,000	16,352	24,000	16,352
2036	Year 9		$21,400,000	$0	$21,400,000	$14,234,912	24,000	15,964	24,000	15,964
2037	Year 10		$21,400,000	$2,943,541	$24,343,541	$15,809,186	24,000	15,586	24,000	15,586
2038	Year 11		$21,400,000	$0	$21,400,000	$13,568,265	24,000	15,217	24,000	15,217
2039	Year 12		$21,400,000	$0	$21,400,000	$13,246,742	24,000	14,856	24,000	14,856
2040	Year 13		$21,400,000	$0	$21,400,000	$12,932,838	24,000	14,504	24,000	14,504
2041	Year 14		$21,400,000	$0	$21,400,000	$12,626,373	24,000	14,160	24,000	14,160
2042	Year 15		$21,400,000	$2,184,046	$23,584,046	$13,585,259	24,000	13,825	24,000	13,825
2043	Year 16		$21,400,000	$665,185	$22,065,185	$12,409,147	24,000	13,497	24,000	13,497

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2044	Year 17		$21,400,000	$0	$21,400,000	$11,749,866	24,000	13,177	24,000	13,177
2045	Year 18		$21,400,000	$0	$21,400,000	$11,471,433	24,000	12,865	24,000	12,865
2046	Year 19		$21,400,000	$0	$21,400,000	$11,199,598	24,000	12,560	24,000	12,560
2047	Year 20		$21,400,000	$20,995,650	$42,395,650	$21,661,809	24,000	12,263	24,000	12,263
2048	Year 21		$21,400,000	$0	$21,400,000	$10,675,100	24,000	11,972	24,000	11,972
2049	Year 22		$21,400,000	$0	$21,400,000	$10,422,136	24,000	11,688	24,000	11,688
2050	Year 23		$21,400,000	$0	$21,400,000	$10,175,166	24,000	11,411	24,000	11,411
2051	Year 24		$21,400,000	$665,185	$22,065,185	$10,242,832	24,000	11,141	24,000	11,141
2052	Year 25		$21,400,000	$189,196,556	$210,596,556	$95,443,974	24,000	10,877	24,000	10,877
2053	Year 26		$21,400,000	$0	$21,400,000	$9,468,818	24,000	10,619	24,000	10,619
2054	Year 27		$21,400,000	$0	$21,400,000	$9,244,439	24,000	10,368	24,000	10,368
2055	Year 28		$21,400,000	$0	$21,400,000	$9,025,376	24,000	10,122	24,000	10,122
2056	Year 29		$21,400,000	$0	$21,400,000	$8,811,505	24,000	9,882	24,000	9,882
2057	Year 30		$21,400,000	$10,007,276	$31,407,276	$12,625,580	24,000	9,648	24,000	9,648
2058	Year 31		$21,400,000	$0	$21,400,000	$8,398,846	24,000	9,419	24,000	9,419
2059	Year 32		$21,400,000	$25,927	$21,425,927	$8,209,756	24,000	9,196	24,000	9,196
2060	Year 33		$21,400,000	$639,258	$22,039,258	$8,244,652	24,000	8,978	24,000	8,978
2061	Year 34		$21,400,000	$0	$21,400,000	$7,815,808	24,000	8,765	24,000	8,765
2062	Year 35		$21,400,000	$0	$21,400,000	$7,630,600	24,000	8,558	24,000	8,558
2063	Year 36		$21,400,000	$0	$21,400,000	$7,449,780	24,000	8,355	24,000	8,355
2064	Year 37		$21,400,000	$0	$21,400,000	$7,273,245	24,000	8,157	24,000	8,157
2065	Year 38		$21,400,000	$0	$21,400,000	$7,100,893	24,000	7,964	24,000	7,964
2066	Year 39		$21,400,000	$0	$21,400,000	$6,932,625	24,000	7,775	24,000	7,775
2067	Year 40		$21,400,000	$24,302,319	$45,702,319	$14,454,629	24,000	7,591	24,000	7,591
2068	Year 41		$21,400,000	$639,258	$22,039,258	$6,805,350	24,000	7,411	24,000	7,411
2069	Year 42		$21,400,000	$0	$21,400,000	$6,451,371	24,000	7,235	24,000	7,235
2070	Year 43		$21,400,000	$0	$21,400,000	$6,298,495	24,000	7,064	24,000	7,064
2071	Year 44		$21,400,000	$0	$21,400,000	$6,149,242	24,000	6,896	24,000	6,896
2072	Year 45		$21,400,000	$2,184,046	$23,584,046	$6,616,234	24,000	6,733	24,000	6,733
2073	Year 46		$21,400,000	$0	$21,400,000	$5,861,261	24,000	6,573	24,000	6,573
2074	Year 47		$21,400,000	$0	$21,400,000	$5,722,369	24,000	6,418	24,000	6,418
2075	Year 48		$21,400,000	$25,927	$21,425,927	$5,593,536	24,000	6,266	24,000	6,266
2076	Year 49		$21,400,000	$639,258	$22,039,258	$5,617,312	24,000	6,117	24,000	6,117
2077	Year 50		$21,400,000	$234,179,890	$255,579,890	$63,597,941	24,000	5,972	24,000	5,972
2078	Year 51		$21,400,000	$0	$21,400,000	$5,198,941	24,000	5,831	24,000	5,831
2079	Year 52		$21,400,000	$0	$21,400,000	$5,075,744	24,000	5,692	24,000	5,692
2080	Year 53		$21,400,000	$0	$21,400,000	$4,955,465	24,000	5,558	24,000	5,558
2081	Year 54		$21,400,000	$0	$21,400,000	$4,838,037	24,000	5,426	24,000	5,426
2082	Year 55		$21,400,000	$0	$21,400,000	$4,723,392	24,000	5,297	24,000	5,297
2083	Year 56		$21,400,000	$25,927	$21,425,927	$4,617,050	24,000	5,172	24,000	5,172
2084	Year 57		$21,400,000	$0	$21,400,000	$4,502,187	24,000	5,049	24,000	5,049
2085	Year 58		$21,400,000	$639,258	$22,039,258	$4,526,802	24,000	4,930	24,000	4,930
2086	Year 59		$21,400,000	$0	$21,400,000	$4,291,341	24,000	4,813	24,000	4,813

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2087	Year 60		$21,400,000	$27,519,151	$48,919,151	$9,577,297	24,000	4,699	24,000	4,699
2088	Year 61		$21,400,000	$2,647	$21,402,647	$4,090,876	24,000	4,587	24,000	4,587
2089	Year 62		$21,400,000	$3,892	$21,403,892	$3,994,168	24,000	4,479	24,000	4,479
2090	Year 63		$21,400,000	$5,665	$21,405,665	$3,899,842	24,000	4,372	24,000	4,372
2091	Year 64		$21,400,000	$34,086	$21,434,086	$3,812,484	24,000	4,269	24,000	4,269
2092	Year 65		$21,400,000	$11,636	$21,411,636	$3,718,242	24,000	4,168	24,000	4,168
2093	Year 66		$21,400,000	$655,687	$22,055,687	$3,739,325	24,000	4,069	24,000	4,069
2094	Year 67		$21,400,000	$22,967	$21,422,967	$3,545,986	24,000	3,973	24,000	3,973
2095	Year 68		$21,400,000	$31,787	$21,431,787	$3,463,383	24,000	3,878	24,000	3,878
2096	Year 69		$21,400,000	$43,559	$21,443,559	$3,383,170	24,000	3,787	24,000	3,787
2097	Year 70		$21,400,000	$4,448,525	$25,848,525	$3,981,507	24,000	3,697	24,000	3,697
2098	Year 71		$21,400,000	$79,366	$21,479,366	$3,230,114	24,000	3,609	24,000	3,609
2099	Year 72		$21,400,000	$131,465	$21,531,465	$3,161,220	24,000	3,524	24,000	3,524
2100	Year 73		$21,400,000	$138,947	$21,538,947	$3,087,383	24,000	3,440	24,000	3,440
2101	Year 74		$21,400,000	$820,362	$22,220,362	$3,109,581	24,000	3,359	24,000	3,359
2102	Year 75		$21,400,000	$246,391,827	$267,791,827	$36,587,507	24,000	3,279	24,000	3,279
2103	Year 76		$21,400,000	$298,592	$21,698,592	$2,894,355	24,000	3,201	24,000	3,201
2104	Year 77		$21,400,000	$377,693	$21,777,693	$2,836,070	24,000	3,125	24,000	3,125
2105	Year 78		$21,400,000	$472,994	$21,872,994	$2,780,981	24,000	3,051	24,000	3,051
2106	Year 79		$21,400,000	$586,447	$21,986,447	$2,729,164	24,000	2,979	24,000	2,979
2107	Year 80		$21,400,000	$24,480,178	$45,880,178	$5,560,123	24,000	2,909	24,000	2,909
2108	Year 81		$21,400,000	$874,875	$22,274,875	$2,635,478	24,000	2,840	24,000	2,840
2109	Year 82		$21,400,000	$1,052,666	$22,452,666	$2,593,563	24,000	2,772	24,000	2,772
2110	Year 83		$21,400,000	$1,893,241	$23,293,241	$2,626,900	24,000	2,707	24,000	2,707
2111	Year 84		$21,400,000	$1,478,941	$22,878,941	$2,519,036	24,000	2,642	24,000	2,642
2112	Year 85		$21,400,000	$1,726,896	$23,126,896	$2,485,996	24,000	2,580	24,000	2,580
2113	Year 86		$21,400,000	$1,996,360	$23,396,360	$2,455,366	24,000	2,519	24,000	2,519
2114	Year 87		$21,400,000	$2,284,906	$23,684,906	$2,426,746	24,000	2,459	24,000	2,459
2115	Year 88		$21,400,000	$2,615,065	$24,015,065	$2,402,267	24,000	2,401	24,000	2,401
2116	Year 89		$21,400,000	$2,904,686	$24,304,686	$2,373,626	24,000	2,344	24,000	2,344
2117	Year 90		$21,400,000	$12,737,659	$34,137,659	$3,254,923	24,000	2,288	24,000	2,288
2118	Year 91		$21,400,000	$4,187,049	$25,587,049	$2,381,836	24,000	2,234	24,000	2,234
2119	Year 92		$21,400,000	$3,862,542	$25,262,542	$2,295,903	24,000	2,181	24,000	2,181
2120	Year 93		$21,400,000	$4,163,371	$25,563,371	$2,268,190	24,000	2,129	24,000	2,129
2121	Year 94		$21,400,000	$4,442,980	$25,842,980	$2,238,663	24,000	2,079	24,000	2,079
2122	Year 95		$21,400,000	$4,694,187	$26,094,187	$2,206,859	24,000	2,030	24,000	2,030
2123	Year 96		$21,400,000	$4,936,178	$26,336,178	$2,174,545	24,000	1,982	24,000	1,982
2124	Year 97		$21,400,000	$5,085,153	$26,485,153	$2,135,024	24,000	1,935	24,000	1,935
2125	Year 98		$21,400,000	$5,213,884	$26,613,884	$2,094,563	24,000	1,889	24,000	1,889
2126	Year 99		$21,400,000	$5,931,940	$27,331,940	$2,100,102	24,000	1,844	24,000	1,844
2127	Year 100		$21,400,000	$292,490,072	$313,890,072	$23,546,817	24,000	1,800	24,000	1,800

[1] ROCM lifecycle costs are placeholders based on the values reported in "Task 5 - Basis of Cost Estimated for ROCM Options FINAL (3-6-20)"by GHD, deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Table 1-4. Life-cycle cost for Portfolio 1d

Portfolio 1d

Summary of Lifecycle Unit Costs ($/AF)							
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only	Unit Costs, including ROC management	
	Upper Bound Yield Estimate	Lower Bound Yield Estimate	Upper Bound Yield Estimate	Lower Bound Yield Estimate		Upper Bound Yield Estimate	Lower Bound Yield Estimate
100-Yr Lifecycle:	$ 2,000	$ 2,000	$ 1,600	$ 1,600	$ 200	$ 2,200	$ 2,200
30-Yr Lifecycle:	$ 2,400	$ 2,400	$ 2,100	$ 2,100	$ 200	$ 2,600	$ 2,600

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	**$585,000,000**	**$2,150,000,000**	**$1,190,000,000**	**$3,925,000,000**	**$1,415,000,000**	**2,400,000**	**742,000**	**2,400,000**	**742,000**
	30-Yr Lifecycle:	**$585,000,000**	**$645,000,000**	**$230,000,000**	**$1,460,000,000**	**$985,000,000**	**720,000**	**419,000**	**720,000**	**419,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$146,250,000		$0	$146,250,000	$129,723,811				
2025		$146,250,000		$0	$146,250,000	$126,649,787				
2026		$146,250,000		$0	$146,250,000	$123,648,608				
2027		$146,250,000		$0	$146,250,000	$120,718,546				
2028	Year 1		$21,500,000	$0	$21,500,000	$17,326,121	24,000	19,341	24,000	19,341
2029	Year 2		$21,500,000	$0	$21,500,000	$16,915,550	24,000	18,882	24,000	18,882
2030	Year 3		$21,500,000	$0	$21,500,000	$16,514,707	24,000	18,435	24,000	18,435
2031	Year 4		$21,500,000	$0	$21,500,000	$16,123,363	24,000	17,998	24,000	17,998
2032	Year 5		$21,500,000	$0	$21,500,000	$15,741,293	24,000	17,572	24,000	17,572
2033	Year 6		$21,500,000	$0	$21,500,000	$15,368,277	24,000	17,155	24,000	17,155
2034	Year 7		$21,500,000	$0	$21,500,000	$15,004,100	24,000	16,749	24,000	16,749
2035	Year 8		$21,500,000	$665,185	$22,165,185	$15,101,761	24,000	16,352	24,000	16,352
2036	Year 9		$21,500,000	$0	$21,500,000	$14,301,430	24,000	15,964	24,000	15,964
2037	Year 10		$21,500,000	$2,943,541	$24,443,541	$15,874,128	24,000	15,586	24,000	15,586
2038	Year 11		$21,500,000	$0	$21,500,000	$13,631,668	24,000	15,217	24,000	15,217
2039	Year 12		$21,500,000	$0	$21,500,000	$13,308,643	24,000	14,856	24,000	14,856
2040	Year 13		$21,500,000	$0	$21,500,000	$12,993,272	24,000	14,504	24,000	14,504
2041	Year 14		$21,500,000	$0	$21,500,000	$12,685,374	24,000	14,160	24,000	14,160
2042	Year 15		$21,500,000	$2,184,046	$23,684,046	$13,642,862	24,000	13,825	24,000	13,825
2043	Year 16		$21,500,000	$665,185	$22,165,185	$12,465,386	24,000	13,497	24,000	13,497

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2044	Year 17		$21,500,000	$0	$21,500,000	$11,804,772	24,000	13,177	24,000	13,177
2045	Year 18		$21,500,000	$0	$21,500,000	$11,525,038	24,000	12,865	24,000	12,865
2046	Year 19		$21,500,000	$0	$21,500,000	$11,251,932	24,000	12,560	24,000	12,560
2047	Year 20		$21,500,000	$22,656,192	$44,156,192	$22,561,348	24,000	12,263	24,000	12,263
2048	Year 21		$21,500,000	$0	$21,500,000	$10,724,984	24,000	11,972	24,000	11,972
2049	Year 22		$21,500,000	$0	$21,500,000	$10,470,837	24,000	11,688	24,000	11,688
2050	Year 23		$21,500,000	$0	$21,500,000	$10,222,713	24,000	11,411	24,000	11,411
2051	Year 24		$21,500,000	$665,185	$22,165,185	$10,289,253	24,000	11,141	24,000	11,141
2052	Year 25		$21,500,000	$189,196,556	$210,696,556	$95,489,294	24,000	10,877	24,000	10,877
2053	Year 26		$21,500,000	$0	$21,500,000	$9,513,065	24,000	10,619	24,000	10,619
2054	Year 27		$21,500,000	$0	$21,500,000	$9,287,637	24,000	10,368	24,000	10,368
2055	Year 28		$21,500,000	$0	$21,500,000	$9,067,551	24,000	10,122	24,000	10,122
2056	Year 29		$21,500,000	$0	$21,500,000	$8,852,680	24,000	9,882	24,000	9,882
2057	Year 30		$21,500,000	$10,007,276	$31,507,276	$12,665,780	24,000	9,648	24,000	9,648
2058	Year 31		$21,500,000	$0	$21,500,000	$8,438,093	24,000	9,419	24,000	9,419
2059	Year 32		$21,500,000	$25,927	$21,525,927	$8,248,072	24,000	9,196	24,000	9,196
2060	Year 33		$21,500,000	$639,258	$22,139,258	$8,282,061	24,000	8,978	24,000	8,978
2061	Year 34		$21,500,000	$0	$21,500,000	$7,852,331	24,000	8,765	24,000	8,765
2062	Year 35		$21,500,000	$0	$21,500,000	$7,666,257	24,000	8,558	24,000	8,558
2063	Year 36		$21,500,000	$0	$21,500,000	$7,484,592	24,000	8,355	24,000	8,355
2064	Year 37		$21,500,000	$0	$21,500,000	$7,307,232	24,000	8,157	24,000	8,157
2065	Year 38		$21,500,000	$0	$21,500,000	$7,134,075	24,000	7,964	24,000	7,964
2066	Year 39		$21,500,000	$0	$21,500,000	$6,965,021	24,000	7,775	24,000	7,775
2067	Year 40		$21,500,000	$25,962,861	$47,462,861	$15,011,450	24,000	7,591	24,000	7,591
2068	Year 41		$21,500,000	$639,258	$22,139,258	$6,836,228	24,000	7,411	24,000	7,411
2069	Year 42		$21,500,000	$0	$21,500,000	$6,481,518	24,000	7,235	24,000	7,235
2070	Year 43		$21,500,000	$0	$21,500,000	$6,327,927	24,000	7,064	24,000	7,064
2071	Year 44		$21,500,000	$0	$21,500,000	$6,177,976	24,000	6,896	24,000	6,896
2072	Year 45		$21,500,000	$2,184,046	$23,684,046	$6,644,288	24,000	6,733	24,000	6,733
2073	Year 46		$21,500,000	$0	$21,500,000	$5,888,650	24,000	6,573	24,000	6,573
2074	Year 47		$21,500,000	$0	$21,500,000	$5,749,109	24,000	6,418	24,000	6,418
2075	Year 48		$21,500,000	$25,927	$21,525,927	$5,619,643	24,000	6,266	24,000	6,266
2076	Year 49		$21,500,000	$639,258	$22,139,258	$5,642,800	24,000	6,117	24,000	6,117
2077	Year 50		$21,500,000	$234,179,890	$255,679,890	$63,622,824	24,000	5,972	24,000	5,972
2078	Year 51		$21,500,000	$0	$21,500,000	$5,223,235	24,000	5,831	24,000	5,831
2079	Year 52		$21,500,000	$0	$21,500,000	$5,099,462	24,000	5,692	24,000	5,692
2080	Year 53		$21,500,000	$0	$21,500,000	$4,978,622	24,000	5,558	24,000	5,558
2081	Year 54		$21,500,000	$0	$21,500,000	$4,860,645	24,000	5,426	24,000	5,426
2082	Year 55		$21,500,000	$0	$21,500,000	$4,745,464	24,000	5,297	24,000	5,297
2083	Year 56		$21,500,000	$25,927	$21,525,927	$4,638,599	24,000	5,172	24,000	5,172
2084	Year 57		$21,500,000	$0	$21,500,000	$4,523,225	24,000	5,049	24,000	5,049
2085	Year 58		$21,500,000	$639,258	$22,139,258	$4,547,341	24,000	4,930	24,000	4,930
2086	Year 59		$21,500,000	$0	$21,500,000	$4,311,394	24,000	4,813	24,000	4,813

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2087	Year 60		$21,500,000	$29,180,249	$50,680,249	$9,922,081	24,000	4,699	24,000	4,699
2088	Year 61		$21,500,000	$3,472	$21,503,472	$4,110,147	24,000	4,587	24,000	4,587
2089	Year 62		$21,500,000	$5,104	$21,505,104	$4,013,055	24,000	4,479	24,000	4,479
2090	Year 63		$21,500,000	$7,428	$21,507,428	$3,918,382	24,000	4,372	24,000	4,372
2091	Year 64		$21,500,000	$36,626	$21,536,626	$3,830,723	24,000	4,269	24,000	4,269
2092	Year 65		$21,500,000	$15,259	$21,515,259	$3,736,237	24,000	4,168	24,000	4,168
2093	Year 66		$21,500,000	$660,803	$22,160,803	$3,757,146	24,000	4,069	24,000	4,069
2094	Year 67		$21,500,000	$30,118	$21,530,118	$3,563,722	24,000	3,973	24,000	3,973
2095	Year 68		$21,500,000	$41,685	$21,541,685	$3,481,143	24,000	3,878	24,000	3,878
2096	Year 69		$21,500,000	$57,121	$21,557,121	$3,401,086	24,000	3,787	24,000	3,787
2097	Year 70		$21,500,000	$4,466,923	$25,966,923	$3,999,744	24,000	3,697	24,000	3,697
2098	Year 71		$21,500,000	$104,077	$21,604,077	$3,248,869	24,000	3,609	24,000	3,609
2099	Year 72		$21,500,000	$164,325	$21,664,325	$3,180,727	24,000	3,524	24,000	3,524
2100	Year 73		$21,500,000	$182,208	$21,682,208	$3,107,917	24,000	3,440	24,000	3,440
2101	Year 74		$21,500,000	$876,750	$22,376,750	$3,131,466	24,000	3,359	24,000	3,359
2102	Year 75		$21,500,000	$246,464,593	$267,964,593	$36,611,111	24,000	3,279	24,000	3,279
2103	Year 76		$21,500,000	$391,559	$21,891,559	$2,920,095	24,000	3,201	24,000	3,201
2104	Year 77		$21,500,000	$495,289	$21,995,289	$2,864,407	24,000	3,125	24,000	3,125
2105	Year 78		$21,500,000	$620,261	$22,120,261	$2,812,419	24,000	3,051	24,000	3,051
2106	Year 79		$21,500,000	$769,039	$22,269,039	$2,764,242	24,000	2,979	24,000	2,979
2107	Year 80		$21,500,000	$26,364,856	$47,864,856	$5,800,642	24,000	2,909	24,000	2,909
2108	Year 81		$21,500,000	$1,147,269	$22,647,269	$2,679,538	24,000	2,840	24,000	2,840
2109	Year 82		$21,500,000	$1,380,416	$22,880,416	$2,642,973	24,000	2,772	24,000	2,772
2110	Year 83		$21,500,000	$2,283,672	$23,783,672	$2,682,208	24,000	2,707	24,000	2,707
2111	Year 84		$21,500,000	$1,939,413	$23,439,413	$2,580,745	24,000	2,642	24,000	2,642
2112	Year 85		$21,500,000	$2,264,569	$23,764,569	$2,554,542	24,000	2,580	24,000	2,580
2113	Year 86		$21,500,000	$2,617,932	$24,117,932	$2,531,092	24,000	2,519	24,000	2,519
2114	Year 87		$21,500,000	$2,996,318	$24,496,318	$2,509,883	24,000	2,459	24,000	2,459
2115	Year 88		$21,500,000	$3,421,201	$24,921,201	$2,492,909	24,000	2,401	24,000	2,401
2116	Year 89		$21,500,000	$3,809,068	$25,309,068	$2,471,715	24,000	2,344	24,000	2,344
2117	Year 90		$21,500,000	$13,742,165	$35,242,165	$3,360,234	24,000	2,288	24,000	2,288
2118	Year 91		$21,500,000	$5,291,664	$26,791,664	$2,493,971	24,000	2,234	24,000	2,234
2119	Year 92		$21,500,000	$5,065,154	$26,565,154	$2,414,287	24,000	2,181	24,000	2,181
2120	Year 93		$21,500,000	$5,459,648	$26,959,648	$2,392,079	24,000	2,129	24,000	2,129
2121	Year 94		$21,500,000	$5,826,314	$27,326,314	$2,367,157	24,000	2,079	24,000	2,079
2122	Year 95		$21,500,000	$6,155,735	$27,655,735	$2,338,923	24,000	2,030	24,000	2,030
2123	Year 96		$21,500,000	$6,464,999	$27,964,999	$2,309,034	24,000	1,982	24,000	1,982
2124	Year 97		$21,500,000	$6,668,429	$28,168,429	$2,270,717	24,000	1,935	24,000	1,935
2125	Year 98		$21,500,000	$6,837,242	$28,337,242	$2,230,194	24,000	1,889	24,000	1,889
2126	Year 99		$21,500,000	$7,579,831	$29,079,831	$2,234,404	24,000	1,844	24,000	1,844
2127	Year 100		$21,500,000	$294,146,223	$315,646,223	$23,678,557	24,000	1,800	24,000	1,800

[1] ROCM lifecycle costs are placeholders based on the values reported in "Task 5 - Basis of Cost Estimated for ROCM Options FINAL (3-6-20)"by GHD, deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Table 1-5. Life-cycle cost for Portfolio 2a

Portfolio 2a

Summary of Lifecycle Unit Costs ($/AF)							
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only	Unit Costs, including ROC management	
	Upper Bound Yield Estimate	Lower Bound Yield Estimate	Upper Bound Yield Estimate	Lower Bound Yield Estimate		Upper Bound Yield Estimate	Lower Bound Yield Estimate
100-Yr Lifecycle:	$ 2,100	$ 2,800	$ 1,800	$ 2,400	$ 200	$ 2,300	$ 3,000
30-Yr Lifecycle:	$ 2,700	$ 3,600	$ 2,500	$ 3,300	$ 200	$ 2,900	$ 3,800

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	**$735,000,000**	**$1,940,000,000**	**$1,105,000,000**	**$3,780,000,000**	**$1,450,000,000**	**2,300,000**	**711,000**	**1,700,000**	**526,000**
	30-Yr Lifecycle:	**$735,000,000**	**$585,000,000**	**$190,000,000**	**$1,510,000,000**	**$1,060,000,000**	**690,000**	**401,000**	**510,000**	**297,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$183,750,000		$0	$183,750,000	$162,986,327				
2025		$183,750,000		$0	$183,750,000	$159,124,092				
2026		$183,750,000		$0	$183,750,000	$155,353,379				
2027		$183,750,000		$0	$183,750,000	$151,672,019				
2028	Year 1		$19,400,000	$0	$19,400,000	$15,633,802	23,000	18,535	17,000	13,700
2029	Year 2		$19,400,000	$0	$19,400,000	$15,263,333	23,000	18,096	17,000	13,375
2030	Year 3		$19,400,000	$0	$19,400,000	$14,901,643	23,000	17,667	17,000	13,058
2031	Year 4		$19,400,000	$0	$19,400,000	$14,548,523	23,000	17,248	17,000	12,749
2032	Year 5		$19,400,000	$0	$19,400,000	$14,203,771	23,000	16,840	17,000	12,447
2033	Year 6		$19,400,000	$0	$19,400,000	$13,867,189	23,000	16,440	17,000	12,152
2034	Year 7		$19,400,000	$0	$19,400,000	$13,538,583	23,000	16,051	17,000	11,864
2035	Year 8		$19,400,000	$487,364	$19,887,364	$13,549,818	23,000	15,671	17,000	11,583
2036	Year 9		$19,400,000	$0	$19,400,000	$12,904,546	23,000	15,299	17,000	11,308
2037	Year 10		$19,400,000	$2,903,459	$22,303,459	$14,484,316	23,000	14,937	17,000	11,040
2038	Year 11		$19,400,000	$0	$19,400,000	$12,300,203	23,000	14,583	17,000	10,779
2039	Year 12		$19,400,000	$0	$19,400,000	$12,008,729	23,000	14,237	17,000	10,523
2040	Year 13		$19,400,000	$0	$19,400,000	$11,724,162	23,000	13,900	17,000	10,274
2041	Year 14		$19,400,000	$0	$19,400,000	$11,446,338	23,000	13,570	17,000	10,030
2042	Year 15		$19,400,000	$1,024,213	$20,424,213	$11,765,081	23,000	13,249	17,000	9,793
2043	Year 16		$19,400,000	$487,364	$19,887,364	$11,184,372	23,000	12,935	17,000	9,561
2044	Year 17		$19,400,000	$0	$19,400,000	$10,651,747	23,000	12,628	17,000	9,334

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2045	Year 18		$19,400,000	$0	$19,400,000	$10,399,336	23,000	12,329	17,000	9,113
2046	Year 19		$19,400,000	$0	$19,400,000	$10,152,907	23,000	12,037	17,000	8,897
2047	Year 20		$19,400,000	$30,255,992	$49,655,992	$25,371,438	23,000	11,752	17,000	8,686
2048	Year 21		$19,400,000	$0	$19,400,000	$9,677,427	23,000	11,473	17,000	8,480
2049	Year 22		$19,400,000	$0	$19,400,000	$9,448,104	23,000	11,201	17,000	8,279
2050	Year 23		$19,400,000	$0	$19,400,000	$9,224,216	23,000	10,936	17,000	8,083
2051	Year 24		$19,400,000	$487,364	$19,887,364	$9,231,871	23,000	10,677	17,000	7,892
2052	Year 25		$19,400,000	$145,389,028	$164,789,028	$74,683,651	23,000	10,424	17,000	7,705
2053	Year 26		$19,400,000	$0	$19,400,000	$8,583,882	23,000	10,177	17,000	7,522
2054	Year 27		$19,400,000	$0	$19,400,000	$8,380,473	23,000	9,936	17,000	7,344
2055	Year 28		$19,400,000	$0	$19,400,000	$8,181,883	23,000	9,700	17,000	7,170
2056	Year 29		$19,400,000	$0	$19,400,000	$7,988,000	23,000	9,470	17,000	7,000
2057	Year 30		$19,400,000	$8,905,362	$28,305,362	$11,378,625	23,000	9,246	17,000	6,834
2058	Year 31		$19,400,000	$0	$19,400,000	$7,613,907	23,000	9,027	17,000	6,672
2059	Year 32		$19,400,000	$148,175	$19,548,175	$7,490,259	23,000	8,813	17,000	6,514
2060	Year 33		$19,400,000	$339,189	$19,739,189	$7,384,221	23,000	8,604	17,000	6,360
2061	Year 34		$19,400,000	$0	$19,400,000	$7,085,359	23,000	8,400	17,000	6,209
2062	Year 35		$19,400,000	$0	$19,400,000	$6,917,460	23,000	8,201	17,000	6,062
2063	Year 36		$19,400,000	$0	$19,400,000	$6,753,539	23,000	8,007	17,000	5,918
2064	Year 37		$19,400,000	$0	$19,400,000	$6,593,502	23,000	7,817	17,000	5,778
2065	Year 38		$19,400,000	$0	$19,400,000	$6,437,258	23,000	7,632	17,000	5,641
2066	Year 39		$19,400,000	$0	$19,400,000	$6,284,716	23,000	7,451	17,000	5,507
2067	Year 40		$19,400,000	$34,173,904	$53,573,904	$16,944,237	23,000	7,274	17,000	5,377
2068	Year 41		$19,400,000	$339,189	$19,739,189	$6,095,127	23,000	7,102	17,000	5,249
2069	Year 42		$19,400,000	$0	$19,400,000	$5,848,439	23,000	6,934	17,000	5,125
2070	Year 43		$19,400,000	$0	$19,400,000	$5,709,851	23,000	6,769	17,000	5,003
2071	Year 44		$19,400,000	$0	$19,400,000	$5,574,546	23,000	6,609	17,000	4,885
2072	Year 45		$19,400,000	$1,024,213	$20,424,213	$5,729,779	23,000	6,452	17,000	4,769
2073	Year 46		$19,400,000	$0	$19,400,000	$5,313,480	23,000	6,299	17,000	4,656
2074	Year 47		$19,400,000	$0	$19,400,000	$5,187,568	23,000	6,150	17,000	4,546
2075	Year 48		$19,400,000	$148,175	$19,548,175	$5,103,323	23,000	6,004	17,000	4,438
2076	Year 49		$19,400,000	$339,189	$19,739,189	$5,031,076	23,000	5,862	17,000	4,333
2077	Year 50		$19,400,000	$180,961,423	$200,361,423	$49,857,498	23,000	5,723	17,000	4,230
2078	Year 51		$19,400,000	$0	$19,400,000	$4,713,059	23,000	5,588	17,000	4,130
2079	Year 52		$19,400,000	$0	$19,400,000	$4,601,375	23,000	5,455	17,000	4,032
2080	Year 53		$19,400,000	$0	$19,400,000	$4,492,338	23,000	5,326	17,000	3,937
2081	Year 54		$19,400,000	$0	$19,400,000	$4,385,884	23,000	5,200	17,000	3,843
2082	Year 55		$19,400,000	$0	$19,400,000	$4,281,953	23,000	5,077	17,000	3,752
2083	Year 56		$19,400,000	$148,175	$19,548,175	$4,212,415	23,000	4,956	17,000	3,663
2084	Year 57		$19,400,000	$0	$19,400,000	$4,081,422	23,000	4,839	17,000	3,577
2085	Year 58		$19,400,000	$339,189	$19,739,189	$4,054,374	23,000	4,724	17,000	3,492
2086	Year 59		$19,400,000	$0	$19,400,000	$3,890,281	23,000	4,612	17,000	3,409
2087	Year 60		$19,400,000	$35,664,167	$55,064,167	$10,780,356	23,000	4,503	17,000	3,328
2088	Year 61		$19,400,000	$8,304	$19,408,304	$3,709,679	23,000	4,396	17,000	3,249

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2089	Year 62		$19,400,000	$12,203	$19,412,203	$3,622,500	23,000	4,292	17,000	3,172
2090	Year 63		$19,400,000	$17,758	$19,417,758	$3,537,671	23,000	4,190	17,000	3,097
2091	Year 64		$19,400,000	$173,755	$19,573,755	$3,481,587	23,000	4,091	17,000	3,024
2092	Year 65		$19,400,000	$36,480	$19,436,480	$3,375,246	23,000	3,994	17,000	2,952
2093	Year 66		$19,400,000	$390,700	$19,790,700	$3,355,319	23,000	3,899	17,000	2,882
2094	Year 67		$19,400,000	$72,007	$19,472,007	$3,223,058	23,000	3,807	17,000	2,814
2095	Year 68		$19,400,000	$99,661	$19,499,661	$3,151,151	23,000	3,717	17,000	2,747
2096	Year 69		$19,400,000	$136,559	$19,536,559	$3,082,301	23,000	3,629	17,000	2,682
2097	Year 70		$19,400,000	$4,591,919	$23,991,919	$3,695,529	23,000	3,543	17,000	2,619
2098	Year 71		$19,400,000	$248,828	$19,648,828	$2,954,834	23,000	3,459	17,000	2,556
2099	Year 72		$19,400,000	$479,056	$19,879,056	$2,918,616	23,000	3,377	17,000	2,496
2100	Year 73		$19,400,000	$435,616	$19,835,616	$2,843,228	23,000	3,297	17,000	2,437
2101	Year 74		$19,400,000	$906,984	$20,306,984	$2,841,817	23,000	3,219	17,000	2,379
2102	Year 75		$19,400,000	$187,301,662	$206,701,662	$28,240,961	23,000	3,142	17,000	2,323
2103	Year 76		$19,400,000	$936,137	$20,336,137	$2,712,619	23,000	3,068	17,000	2,268
2104	Year 77		$19,400,000	$1,184,127	$20,584,127	$2,680,634	23,000	2,995	17,000	2,214
2105	Year 78		$19,400,000	$1,482,910	$20,882,910	$2,655,100	23,000	2,924	17,000	2,161
2106	Year 79		$19,400,000	$1,838,602	$21,238,602	$2,636,334	23,000	2,855	17,000	2,110
2107	Year 80		$19,400,000	$35,831,512	$55,231,512	$6,693,392	23,000	2,787	17,000	2,060
2108	Year 81		$19,400,000	$2,742,872	$22,142,872	$2,619,860	23,000	2,721	17,000	2,011
2109	Year 82		$19,400,000	$3,300,276	$22,700,276	$2,622,165	23,000	2,657	17,000	1,964
2110	Year 83		$19,400,000	$4,270,628	$23,670,628	$2,669,460	23,000	2,594	17,000	1,917
2111	Year 84		$19,400,000	$4,636,715	$24,036,715	$2,646,510	23,000	2,532	17,000	1,872
2112	Year 85		$19,400,000	$5,414,096	$24,814,096	$2,667,360	23,000	2,472	17,000	1,827
2113	Year 86		$19,400,000	$6,258,910	$25,658,910	$2,692,813	23,000	2,414	17,000	1,784
2114	Year 87		$19,400,000	$7,163,551	$26,563,551	$2,721,691	23,000	2,357	17,000	1,742
2115	Year 88		$19,400,000	$8,265,543	$27,665,543	$2,767,430	23,000	2,301	17,000	1,701
2116	Year 89		$19,400,000	$9,106,660	$28,506,660	$2,783,996	23,000	2,246	17,000	1,660
2117	Year 90		$19,400,000	$18,935,529	$38,335,529	$3,655,177	23,000	2,193	17,000	1,621
2118	Year 91		$19,400,000	$11,462,089	$30,862,089	$2,872,877	23,000	2,141	17,000	1,582
2119	Year 92		$19,400,000	$12,109,690	$31,509,690	$2,863,655	23,000	2,090	17,000	1,545
2120	Year 93		$19,400,000	$13,052,843	$32,452,843	$2,879,480	23,000	2,041	17,000	1,508
2121	Year 94		$19,400,000	$13,929,461	$33,329,461	$2,887,183	23,000	1,992	17,000	1,473
2122	Year 95		$19,400,000	$14,717,040	$34,117,040	$2,885,374	23,000	1,945	17,000	1,438
2123	Year 96		$19,400,000	$15,542,609	$34,942,609	$2,885,167	23,000	1,899	17,000	1,404
2124	Year 97		$19,400,000	$15,942,779	$35,342,779	$2,849,056	23,000	1,854	17,000	1,370
2125	Year 98		$19,400,000	$16,346,372	$35,746,372	$2,813,307	23,000	1,810	17,000	1,338
2126	Year 99		$19,400,000	$16,932,606	$36,332,606	$2,791,685	23,000	1,767	17,000	1,306
2127	Year 100		$19,400,000	$221,249,389	$240,649,389	$18,052,585	23,000	1,725	17,000	1,275

[1] ROCM lifecycle costs are placeholders based on the values reported in "Task 5 - Basis of Cost Estimated for ROCM Options FINAL (3-6-20)"by GHD, deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Table 1-6. Life-cycle cost for Portfolio 2b

Portfolio 2b

Summary of Lifecycle Unit Costs ($/AF)							
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only	Unit Costs, including ROC management	
	Upper Bound Yield Estimate	Lower Bound Yield Estimate	Upper Bound Yield Estimate	Lower Bound Yield Estimate		Upper Bound Yield Estimate	Lower Bound Yield Estimate
100-Yr Lifecycle:	$ 2,100	$ 2,800	$ 1,800	$ 2,400	$ 200	$ 2,300	$ 3,000
30-Yr Lifecycle:	$ 2,700	$ 3,600	$ 2,500	$ 3,300	$ 200	$ 2,900	$ 3,800

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
100-Yr Lifecycle:		**$755,000,000**	**$1,860,000,000**	**$1,085,000,000**	**$3,700,000,000**	**$1,440,000,000**	**2,300,000**	**711,000**	**1,700,000**	**526,000**
30-Yr Lifecycle:		**$755,000,000**	**$560,000,000**	**$190,000,000**	**$1,505,000,000**	**$1,060,000,000**	**690,000**	**401,000**	**510,000**	**297,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$188,750,000		$0	$188,750,000	$167,421,329				
2025		$188,750,000		$0	$188,750,000	$163,453,999				
2026		$188,750,000		$0	$188,750,000	$159,580,682				
2027		$188,750,000		$0	$188,750,000	$155,799,149				
2028	Year 1		$18,600,000	$0	$18,600,000	$14,989,109	23,000	18,535	17,000	13,700
2029	Year 2		$18,600,000	$0	$18,600,000	$14,633,917	23,000	18,096	17,000	13,375
2030	Year 3		$18,600,000	$0	$18,600,000	$14,287,142	23,000	17,667	17,000	13,058
2031	Year 4		$18,600,000	$0	$18,600,000	$13,948,584	23,000	17,248	17,000	12,749
2032	Year 5		$18,600,000	$0	$18,600,000	$13,618,049	23,000	16,840	17,000	12,447
2033	Year 6		$18,600,000	$0	$18,600,000	$13,295,346	23,000	16,440	17,000	12,152
2034	Year 7		$18,600,000	$0	$18,600,000	$12,980,291	23,000	16,051	17,000	11,864
2035	Year 8		$18,600,000	$487,364	$19,087,364	$13,004,756	23,000	15,671	17,000	11,583
2036	Year 9		$18,600,000	$0	$18,600,000	$12,372,400	23,000	15,299	17,000	11,308
2037	Year 10		$18,600,000	$2,648,775	$21,248,775	$13,799,383	23,000	14,937	17,000	11,040
2038	Year 11		$18,600,000	$0	$18,600,000	$11,792,978	23,000	14,583	17,000	10,779
2039	Year 12		$18,600,000	$0	$18,600,000	$11,513,523	23,000	14,237	17,000	10,523
2040	Year 13		$18,600,000	$0	$18,600,000	$11,240,691	23,000	13,900	17,000	10,274
2041	Year 14		$18,600,000	$0	$18,600,000	$10,974,324	23,000	13,570	17,000	10,030
2042	Year 15		$18,600,000	$1,024,213	$19,624,213	$11,304,252	23,000	13,249	17,000	9,793
2043	Year 16		$18,600,000	$487,364	$19,087,364	$10,734,463	23,000	12,935	17,000	9,561
2044	Year 17		$18,600,000	$0	$18,600,000	$10,212,500	23,000	12,628	17,000	9,334

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2045	Year 18		$18,600,000	$0	$18,600,000	$9,970,498	23,000	12,329	17,000	9,113
2046	Year 19		$18,600,000	$0	$18,600,000	$9,734,230	23,000	12,037	17,000	8,897
2047	Year 20		$18,600,000	$28,631,481	$47,231,481	$24,132,648	23,000	11,752	17,000	8,686
2048	Year 21		$18,600,000	$0	$18,600,000	$9,278,358	23,000	11,473	17,000	8,480
2049	Year 22		$18,600,000	$0	$18,600,000	$9,058,492	23,000	11,201	17,000	8,279
2050	Year 23		$18,600,000	$0	$18,600,000	$8,843,836	23,000	10,936	17,000	8,083
2051	Year 24		$18,600,000	$487,364	$19,087,364	$8,860,504	23,000	10,677	17,000	7,892
2052	Year 25		$18,600,000	$145,437,673	$164,037,673	$74,343,131	23,000	10,424	17,000	7,705
2053	Year 26		$18,600,000	$0	$18,600,000	$8,229,908	23,000	10,177	17,000	7,522
2054	Year 27		$18,600,000	$0	$18,600,000	$8,034,886	23,000	9,936	17,000	7,344
2055	Year 28		$18,600,000	$0	$18,600,000	$7,844,486	23,000	9,700	17,000	7,170
2056	Year 29		$18,600,000	$0	$18,600,000	$7,658,598	23,000	9,470	17,000	7,000
2057	Year 30		$18,600,000	$8,747,522	$27,347,522	$10,993,578	23,000	9,246	17,000	6,834
2058	Year 31		$18,600,000	$0	$18,600,000	$7,299,931	23,000	9,027	17,000	6,672
2059	Year 32		$18,600,000	$148,175	$18,748,175	$7,183,723	23,000	8,813	17,000	6,514
2060	Year 33		$18,600,000	$339,189	$18,939,189	$7,084,949	23,000	8,604	17,000	6,360
2061	Year 34		$18,600,000	$0	$18,600,000	$6,793,179	23,000	8,400	17,000	6,209
2062	Year 35		$18,600,000	$0	$18,600,000	$6,632,203	23,000	8,201	17,000	6,062
2063	Year 36		$18,600,000	$0	$18,600,000	$6,475,042	23,000	8,007	17,000	5,918
2064	Year 37		$18,600,000	$0	$18,600,000	$6,321,605	23,000	7,817	17,000	5,778
2065	Year 38		$18,600,000	$0	$18,600,000	$6,171,804	23,000	7,632	17,000	5,641
2066	Year 39		$18,600,000	$0	$18,600,000	$6,025,553	23,000	7,451	17,000	5,507
2067	Year 40		$18,600,000	$32,549,393	$51,149,393	$16,177,418	23,000	7,274	17,000	5,377
2068	Year 41		$18,600,000	$339,189	$18,939,189	$5,848,101	23,000	7,102	17,000	5,249
2069	Year 42		$18,600,000	$0	$18,600,000	$5,607,267	23,000	6,934	17,000	5,125
2070	Year 43		$18,600,000	$0	$18,600,000	$5,474,393	23,000	6,769	17,000	5,003
2071	Year 44		$18,600,000	$0	$18,600,000	$5,344,668	23,000	6,609	17,000	4,885
2072	Year 45		$18,600,000	$1,024,213	$19,624,213	$5,505,348	23,000	6,452	17,000	4,769
2073	Year 46		$18,600,000	$0	$18,600,000	$5,094,367	23,000	6,299	17,000	4,656
2074	Year 47		$18,600,000	$0	$18,600,000	$4,973,648	23,000	6,150	17,000	4,546
2075	Year 48		$18,600,000	$148,175	$18,748,175	$4,894,472	23,000	6,004	17,000	4,438
2076	Year 49		$18,600,000	$339,189	$18,939,189	$4,827,174	23,000	5,862	17,000	4,333
2077	Year 50		$18,600,000	$180,118,673	$198,718,673	$49,448,720	23,000	5,723	17,000	4,230
2078	Year 51		$18,600,000	$0	$18,600,000	$4,518,706	23,000	5,588	17,000	4,130
2079	Year 52		$18,600,000	$0	$18,600,000	$4,411,628	23,000	5,455	17,000	4,032
2080	Year 53		$18,600,000	$0	$18,600,000	$4,307,087	23,000	5,326	17,000	3,937
2081	Year 54		$18,600,000	$0	$18,600,000	$4,205,023	23,000	5,200	17,000	3,843
2082	Year 55		$18,600,000	$0	$18,600,000	$4,105,378	23,000	5,077	17,000	3,752
2083	Year 56		$18,600,000	$148,175	$18,748,175	$4,040,024	23,000	4,956	17,000	3,663
2084	Year 57		$18,600,000	$0	$18,600,000	$3,913,116	23,000	4,839	17,000	3,577
2085	Year 58		$18,600,000	$339,189	$18,939,189	$3,890,056	23,000	4,724	17,000	3,492
2086	Year 59		$18,600,000	$0	$18,600,000	$3,729,857	23,000	4,612	17,000	3,409

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2087	Year 60		$18,600,000	$34,193,362	$52,793,362	$10,335,782	23,000	4,503	17,000	3,328
2088	Year 61		$18,600,000	$7,648	$18,607,648	$3,556,643	23,000	4,396	17,000	3,249
2089	Year 62		$18,600,000	$11,240	$18,611,240	$3,473,033	23,000	4,292	17,000	3,172
2090	Year 63		$18,600,000	$16,355	$18,616,355	$3,391,665	23,000	4,190	17,000	3,097
2091	Year 64		$18,600,000	$171,735	$18,771,735	$3,338,931	23,000	4,091	17,000	3,024
2092	Year 65		$18,600,000	$33,600	$18,633,600	$3,235,822	23,000	3,994	17,000	2,952
2093	Year 66		$18,600,000	$386,633	$18,986,633	$3,218,997	23,000	3,899	17,000	2,882
2094	Year 67		$18,600,000	$66,321	$18,666,321	$3,089,699	23,000	3,807	17,000	2,814
2095	Year 68		$18,600,000	$91,792	$18,691,792	$3,020,599	23,000	3,717	17,000	2,747
2096	Year 69		$18,600,000	$125,778	$18,725,778	$2,954,383	23,000	3,629	17,000	2,682
2097	Year 70		$18,600,000	$4,265,304	$22,865,304	$3,521,994	23,000	3,543	17,000	2,619
2098	Year 71		$18,600,000	$229,183	$18,829,183	$2,831,574	23,000	3,459	17,000	2,556
2099	Year 72		$18,600,000	$452,933	$19,052,933	$2,797,326	23,000	3,377	17,000	2,496
2100	Year 73		$18,600,000	$401,222	$19,001,222	$2,723,626	23,000	3,297	17,000	2,437
2101	Year 74		$18,600,000	$862,155	$19,462,155	$2,723,590	23,000	3,219	17,000	2,379
2102	Year 75		$18,600,000	$195,987,127	$214,587,127	$29,318,326	23,000	3,142	17,000	2,323
2103	Year 76		$18,600,000	$862,225	$19,462,225	$2,596,048	23,000	3,068	17,000	2,268
2104	Year 77		$18,600,000	$1,090,638	$19,690,638	$2,564,276	23,000	2,995	17,000	2,214
2105	Year 78		$18,600,000	$1,365,830	$19,965,830	$2,538,500	23,000	2,924	17,000	2,161
2106	Year 79		$18,600,000	$1,693,440	$20,293,440	$2,519,012	23,000	2,855	17,000	2,110
2107	Year 80		$18,600,000	$34,086,114	$52,686,114	$6,384,920	23,000	2,787	17,000	2,060
2108	Year 81		$18,600,000	$2,526,314	$21,126,314	$2,499,584	23,000	2,721	17,000	2,011
2109	Year 82		$18,600,000	$3,039,709	$21,639,709	$2,499,656	23,000	2,657	17,000	1,964
2110	Year 83		$18,600,000	$3,960,229	$22,560,229	$2,544,234	23,000	2,594	17,000	1,917
2111	Year 84		$18,600,000	$4,270,632	$22,870,632	$2,518,121	23,000	2,532	17,000	1,872
2112	Year 85		$18,600,000	$4,986,636	$23,586,636	$2,535,416	23,000	2,472	17,000	1,827
2113	Year 86		$18,600,000	$5,764,749	$24,364,749	$2,556,995	23,000	2,414	17,000	1,784
2114	Year 87		$18,600,000	$6,597,967	$25,197,967	$2,581,774	23,000	2,357	17,000	1,742
2115	Year 88		$18,600,000	$7,624,651	$26,224,651	$2,623,295	23,000	2,301	17,000	1,701
2116	Year 89		$18,600,000	$8,387,661	$26,987,661	$2,635,648	23,000	2,246	17,000	1,660
2117	Year 90		$18,600,000	$17,824,941	$36,424,941	$3,473,008	23,000	2,193	17,000	1,621
2118	Year 91		$18,600,000	$10,583,900	$29,183,900	$2,716,659	23,000	2,141	17,000	1,582
2119	Year 92		$18,600,000	$11,153,591	$29,753,591	$2,704,057	23,000	2,090	17,000	1,545
2120	Year 93		$18,600,000	$12,022,280	$30,622,280	$2,717,057	23,000	2,041	17,000	1,508
2121	Year 94		$18,600,000	$12,829,686	$31,429,686	$2,722,614	23,000	1,992	17,000	1,473
2122	Year 95		$18,600,000	$13,555,083	$32,155,083	$2,719,446	23,000	1,945	17,000	1,438
2123	Year 96		$18,600,000	$14,327,169	$32,927,169	$2,718,754	23,000	1,899	17,000	1,404
2124	Year 97		$18,600,000	$14,684,045	$33,284,045	$2,683,097	23,000	1,854	17,000	1,370
2125	Year 98		$18,600,000	$15,055,773	$33,655,773	$2,648,773	23,000	1,810	17,000	1,338
2126	Year 99		$18,600,000	$15,622,502	$34,222,502	$2,629,551	23,000	1,767	17,000	1,306
2127	Year 100		$18,600,000	$219,976,269	$238,576,269	$17,897,067	23,000	1,725	17,000	1,275

Table 1-7. Life-cycle cost for Portfolio 4

Portfolio 4

Summary of Lifecycle Unit Costs ($/AF)							
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only	Unit Costs, including ROC management	
	Upper Bound Yield Estimate	Lower Bound Yield Estimate	Upper Bound Yield Estimate	Lower Bound Yield Estimate		Upper Bound Yield Estimate	Lower Bound Yield Estimate
100-Yr Lifecycle:	$ 2,200	$ 3,000	$ 1,900	$ 2,500	$ 200	$ 2,400	$ 3,200
30-Yr Lifecycle:	$ 2,800	$ 3,800	$ 2,600	$ 3,500	$ 200	$ 3,000	$ 4,000

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
100-Yr Lifecycle:		**$775,000,000**	**$2,020,000,000**	**$1,200,000,000**	**$3,995,000,000**	**$1,535,000,000**	**2,300,000**	**711,000**	**1,700,000**	**526,000**
30-Yr Lifecycle:		**$775,000,000**	**$610,000,000**	**$220,000,000**	**$1,600,000,000**	**$1,120,000,000**	**690,000**	**401,000**	**510,000**	**297,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$193,750,000		$0	$193,750,000	$171,856,331				
2025		$193,750,000		$0	$193,750,000	$167,783,906				
2026		$193,750,000		$0	$193,750,000	$163,807,984				
2027		$193,750,000		$0	$193,750,000	$159,926,279				
2028	Year 1		$20,200,000	$0	$20,200,000	$16,278,495	23,000	18,535	17,000	13,700
2029	Year 2		$20,200,000	$0	$20,200,000	$15,892,749	23,000	18,096	17,000	13,375
2030	Year 3		$20,200,000	$0	$20,200,000	$15,516,143	23,000	17,667	17,000	13,058
2031	Year 4		$20,200,000	$0	$20,200,000	$15,148,462	23,000	17,248	17,000	12,749
2032	Year 5		$20,200,000	$0	$20,200,000	$14,789,494	23,000	16,840	17,000	12,447
2033	Year 6		$20,200,000	$0	$20,200,000	$14,439,032	23,000	16,440	17,000	12,152
2034	Year 7		$20,200,000	$0	$20,200,000	$14,096,875	23,000	16,051	17,000	11,864
2035	Year 8		$20,200,000	$738,227	$20,938,227	$14,265,800	23,000	15,671	17,000	11,583
2036	Year 9		$20,200,000	$0	$20,200,000	$13,436,692	23,000	15,299	17,000	11,308
2037	Year 10		$20,200,000	$4,314,078	$24,514,078	$15,919,937	23,000	14,937	17,000	11,040
2038	Year 11		$20,200,000	$0	$20,200,000	$12,807,427	23,000	14,583	17,000	10,779
2039	Year 12		$20,200,000	$0	$20,200,000	$12,503,934	23,000	14,237	17,000	10,523
2040	Year 13		$20,200,000	$0	$20,200,000	$12,207,632	23,000	13,900	17,000	10,274
2041	Year 14		$20,200,000	$0	$20,200,000	$11,918,352	23,000	13,570	17,000	10,030
2042	Year 15		$20,200,000	$1,169,282	$21,369,282	$12,309,475	23,000	13,249	17,000	9,793
2043	Year 16		$20,200,000	$738,227	$20,938,227	$11,775,362	23,000	12,935	17,000	9,561
2044	Year 17		$20,200,000	$0	$20,200,000	$11,090,995	23,000	12,628	17,000	9,334
2045	Year 18		$20,200,000	$0	$20,200,000	$10,828,175	23,000	12,329	17,000	9,113
2046	Year 19		$20,200,000	$0	$20,200,000	$10,571,583	23,000	12,037	17,000	8,897

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2047	Year 20		$20,200,000	$30,870,594	$51,070,594	$26,094,221	23,000	11,752	17,000	8,686
2048	Year 21		$20,200,000	$0	$20,200,000	$10,076,496	23,000	11,473	17,000	8,480
2049	Year 22		$20,200,000	$0	$20,200,000	$9,837,717	23,000	11,201	17,000	8,279
2050	Year 23		$20,200,000	$0	$20,200,000	$9,604,596	23,000	10,936	17,000	8,083
2051	Year 24		$20,200,000	$738,227	$20,938,227	$9,719,689	23,000	10,677	17,000	7,892
2052	Year 25		$20,200,000	$166,277,411	$186,477,411	$84,512,992	23,000	10,424	17,000	7,705
2053	Year 26		$20,200,000	$0	$20,200,000	$8,937,857	23,000	10,177	17,000	7,522
2054	Year 27		$20,200,000	$0	$20,200,000	$8,726,059	23,000	9,936	17,000	7,344
2055	Year 28		$20,200,000	$0	$20,200,000	$8,519,280	23,000	9,700	17,000	7,170
2056	Year 29		$20,200,000	$0	$20,200,000	$8,317,402	23,000	9,470	17,000	7,000
2057	Year 30		$20,200,000	$11,618,500	$31,818,500	$12,790,890	23,000	9,246	17,000	6,834
2058	Year 31		$20,200,000	$0	$20,200,000	$7,927,883	23,000	9,027	17,000	6,672
2059	Year 32		$20,200,000	$222,288	$20,422,288	$7,825,192	23,000	8,813	17,000	6,514
2060	Year 33		$20,200,000	$515,939	$20,715,939	$7,749,613	23,000	8,604	17,000	6,360
2061	Year 34		$20,200,000	$0	$20,200,000	$7,377,539	23,000	8,400	17,000	6,209
2062	Year 35		$20,200,000	$0	$20,200,000	$7,202,716	23,000	8,201	17,000	6,062
2063	Year 36		$20,200,000	$0	$20,200,000	$7,032,035	23,000	8,007	17,000	5,918
2064	Year 37		$20,200,000	$0	$20,200,000	$6,865,399	23,000	7,817	17,000	5,778
2065	Year 38		$20,200,000	$0	$20,200,000	$6,702,712	23,000	7,632	17,000	5,641
2066	Year 39		$20,200,000	$0	$20,200,000	$6,543,880	23,000	7,451	17,000	5,507
2067	Year 40		$20,200,000	$38,336,107	$58,536,107	$18,513,672	23,000	7,274	17,000	5,377
2068	Year 41		$20,200,000	$515,939	$20,715,939	$6,396,731	23,000	7,102	17,000	5,249
2069	Year 42		$20,200,000	$0	$20,200,000	$6,089,612	23,000	6,934	17,000	5,125
2070	Year 43		$20,200,000	$0	$20,200,000	$5,945,308	23,000	6,769	17,000	5,003
2071	Year 44		$20,200,000	$0	$20,200,000	$5,804,424	23,000	6,609	17,000	4,885
2072	Year 45		$20,200,000	$1,169,282	$21,369,282	$5,994,907	23,000	6,452	17,000	4,769
2073	Year 46		$20,200,000	$0	$20,200,000	$5,532,592	23,000	6,299	17,000	4,656
2074	Year 47		$20,200,000	$0	$20,200,000	$5,401,488	23,000	6,150	17,000	4,546
2075	Year 48		$20,200,000	$222,288	$20,422,288	$5,331,522	23,000	6,004	17,000	4,438
2076	Year 49		$20,200,000	$515,939	$20,715,939	$5,280,028	23,000	5,862	17,000	4,333
2077	Year 50		$20,200,000	$206,086,466	$226,286,466	$56,308,629	23,000	5,723	17,000	4,230
2078	Year 51		$20,200,000	$0	$20,200,000	$4,907,412	23,000	5,588	17,000	4,130
2079	Year 52		$20,200,000	$0	$20,200,000	$4,791,122	23,000	5,455	17,000	4,032
2080	Year 53		$20,200,000	$0	$20,200,000	$4,677,589	23,000	5,326	17,000	3,937
2081	Year 54		$20,200,000	$0	$20,200,000	$4,566,745	23,000	5,200	17,000	3,843
2082	Year 55		$20,200,000	$0	$20,200,000	$4,458,529	23,000	5,077	17,000	3,752
2083	Year 56		$20,200,000	$222,288	$20,422,288	$4,400,777	23,000	4,956	17,000	3,663
2084	Year 57		$20,200,000	$0	$20,200,000	$4,249,728	23,000	4,839	17,000	3,577
2085	Year 58		$20,200,000	$515,939	$20,715,939	$4,254,996	23,000	4,724	17,000	3,492
2086	Year 59		$20,200,000	$0	$20,200,000	$4,050,705	23,000	4,612	17,000	3,409
2087	Year 60		$20,200,000	$37,640,261	$57,840,261	$11,323,854	23,000	4,503	17,000	3,328
2088	Year 61		$20,200,000	$6,926	$20,206,926	$3,862,327	23,000	4,396	17,000	3,249
2089	Year 62		$20,200,000	$10,180	$20,210,180	$3,771,410	23,000	4,292	17,000	3,172
2090	Year 63		$20,200,000	$14,811	$20,214,811	$3,682,884	23,000	4,190	17,000	3,097
2091	Year 64		$20,200,000	$243,626	$20,443,626	$3,636,311	23,000	4,091	17,000	3,024

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2092	Year 65		$20,200,000	$30,428	$20,230,428	$3,513,119	23,000	3,994	17,000	2,952
2093	Year 66		$20,200,000	$558,904	$20,758,904	$3,519,468	23,000	3,899	17,000	2,882
2094	Year 67		$20,200,000	$60,062	$20,260,062	$3,353,499	23,000	3,807	17,000	2,814
2095	Year 68		$20,200,000	$83,128	$20,283,128	$3,277,759	23,000	3,717	17,000	2,747
2096	Year 69		$20,200,000	$113,906	$20,313,906	$3,204,943	23,000	3,629	17,000	2,682
2097	Year 70		$20,200,000	$5,959,531	$26,159,531	$4,029,412	23,000	3,543	17,000	2,619
2098	Year 71		$20,200,000	$207,552	$20,407,552	$3,068,933	23,000	3,459	17,000	2,556
2099	Year 72		$20,200,000	$498,283	$20,698,283	$3,038,894	23,000	3,377	17,000	2,496
2100	Year 73		$20,200,000	$363,356	$20,563,356	$2,947,542	23,000	3,297	17,000	2,437
2101	Year 74		$20,200,000	$989,549	$21,189,549	$2,965,326	23,000	3,219	17,000	2,379
2102	Year 75		$20,200,000	$222,533,458	$242,733,458	$33,163,865	23,000	3,142	17,000	2,323
2103	Year 76		$20,200,000	$780,850	$20,980,850	$2,798,616	23,000	3,068	17,000	2,268
2104	Year 77		$20,200,000	$987,705	$21,187,705	$2,759,237	23,000	2,995	17,000	2,214
2105	Year 78		$20,200,000	$1,236,926	$21,436,926	$2,725,538	23,000	2,924	17,000	2,161
2106	Year 79		$20,200,000	$1,533,615	$21,733,615	$2,697,780	23,000	2,855	17,000	2,110
2107	Year 80		$20,200,000	$39,679,236	$59,879,236	$7,256,640	23,000	2,787	17,000	2,060
2108	Year 81		$20,200,000	$2,287,885	$22,487,885	$2,660,680	23,000	2,721	17,000	2,011
2109	Year 82		$20,200,000	$2,752,827	$22,952,827	$2,651,338	23,000	2,657	17,000	1,964
2110	Year 83		$20,200,000	$3,795,231	$23,995,231	$2,706,067	23,000	2,594	17,000	1,917
2111	Year 84		$20,200,000	$3,867,575	$24,067,575	$2,649,908	23,000	2,532	17,000	1,872
2112	Year 85		$20,200,000	$4,516,006	$24,716,006	$2,656,816	23,000	2,472	17,000	1,827
2113	Year 86		$20,200,000	$5,220,685	$25,420,685	$2,667,812	23,000	2,414	17,000	1,784
2114	Year 87		$20,200,000	$5,975,263	$26,175,263	$2,681,907	23,000	2,357	17,000	1,742
2115	Year 88		$20,200,000	$6,993,148	$27,193,148	$2,720,176	23,000	2,301	17,000	1,701
2116	Year 89		$20,200,000	$7,596,048	$27,796,048	$2,714,596	23,000	2,246	17,000	1,660
2117	Year 90		$20,200,000	$19,329,408	$39,529,408	$3,769,010	23,000	2,193	17,000	1,621
2118	Year 91		$20,200,000	$9,793,774	$29,993,774	$2,792,048	23,000	2,141	17,000	1,582
2119	Year 92		$20,200,000	$10,100,936	$30,300,936	$2,753,801	23,000	2,090	17,000	1,545
2120	Year 93		$20,200,000	$10,887,639	$31,087,639	$2,758,348	23,000	2,041	17,000	1,508
2121	Year 94		$20,200,000	$11,618,841	$31,818,841	$2,756,325	23,000	1,992	17,000	1,473
2122	Year 95		$20,200,000	$12,275,780	$32,475,780	$2,746,568	23,000	1,945	17,000	1,438
2123	Year 96		$20,200,000	$13,063,096	$33,263,096	$2,746,491	23,000	1,899	17,000	1,404
2124	Year 97		$20,200,000	$13,298,193	$33,498,193	$2,700,360	23,000	1,854	17,000	1,370
2125	Year 98		$20,200,000	$13,634,837	$33,834,837	$2,662,865	23,000	1,810	17,000	1,338
2126	Year 99		$20,200,000	$14,356,843	$34,556,843	$2,655,241	23,000	1,767	17,000	1,306
2127	Year 100		$20,200,000	$249,162,444	$269,362,444	$20,206,527	23,000	1,725	17,000	1,275

[1] ROCM lifecycle costs are placeholders based on the values reported in "Task 5 - Basis of Cost Estimated for ROCM Options FINAL (3-6-20)"by GHD, deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Table 1-8. Life-cycle cost for Morgan Hill Option 1 (NPR+ from SBWR)

Morgan Hill - Option 1

Summary of Lifecycle Unit Costs ($/AF)

Time Horizon	Unit Costs, excluding ROC management	Unit Costs, excluding R&R and ROC management	ROCM Unit Costs Only	Unit Costs, including ROC management
100-Yr Lifecycle:	$ 1,700	$ 1,600	$ -	$ 1,700
30-Yr Lifecycle:	$ 2,200	$ 2,200	$ -	$ 2,200

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
	100-Yr Lifecycle:	**$70,000,000**	**$260,000,000**	**$20,000,000**	**$350,000,000**	**$145,000,000**	**290,000**	**90,000**
	30-Yr Lifecycle:	**$70,000,000**	**$80,000,000**	**$5,000,000**	**$150,000,000**	**$110,000,000**	**87,000**	**51,000**
2019				$0	$0	$0		
2020				$0	$0	$0		
2021				$0	$0	$0		
2022				$0	$0	$0		
2023				$0	$0	$0		
2024		$17,500,000		$0	$17,500,000	$15,522,507		
2025		$17,500,000		$0	$17,500,000	$15,154,675		
2026		$17,500,000		$0	$17,500,000	$14,795,560		
2027		$17,500,000		$0	$17,500,000	$14,444,954		
2028	Year 1		$2,600,000	$0	$2,600,000	$2,095,252	2,900	2,337
2029	Year 2		$2,600,000	$0	$2,600,000	$2,045,601	2,900	2,282
2030	Year 3		$2,600,000	$0	$2,600,000	$1,997,127	2,900	2,228
2031	Year 4		$2,600,000	$0	$2,600,000	$1,949,802	2,900	2,175
2032	Year 5		$2,600,000	$0	$2,600,000	$1,903,598	2,900	2,123
2033	Year 6		$2,600,000	$0	$2,600,000	$1,858,489	2,900	2,073
2034	Year 7		$2,600,000	$0	$2,600,000	$1,814,449	2,900	2,024
2035	Year 8		$2,600,000	$0	$2,600,000	$1,771,453	2,900	1,976
2036	Year 9		$2,600,000	$0	$2,600,000	$1,729,475	2,900	1,929
2037	Year 10		$2,600,000	$0	$2,600,000	$1,688,492	2,900	1,883
2038	Year 11		$2,600,000	$0	$2,600,000	$1,648,481	2,900	1,839
2039	Year 12		$2,600,000	$0	$2,600,000	$1,609,417	2,900	1,795
2040	Year 13		$2,600,000	$0	$2,600,000	$1,571,279	2,900	1,753
2041	Year 14		$2,600,000	$0	$2,600,000	$1,534,045	2,900	1,711
2042	Year 15		$2,600,000	$0	$2,600,000	$1,497,693	2,900	1,671
2043	Year 16		$2,600,000	$0	$2,600,000	$1,462,203	2,900	1,631
2044	Year 17		$2,600,000	$0	$2,600,000	$1,427,554	2,900	1,592
2045	Year 18		$2,600,000	$0	$2,600,000	$1,393,725	2,900	1,555
2046	Year 19		$2,600,000	$0	$2,600,000	$1,360,699	2,900	1,518

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2047	Year 20		$2,600,000	$1,034,018	$3,634,018	$1,856,780	2,900	1,482
2048	Year 21		$2,600,000	$0	$2,600,000	$1,296,975	2,900	1,447
2049	Year 22		$2,600,000	$0	$2,600,000	$1,266,241	2,900	1,412
2050	Year 23		$2,600,000	$0	$2,600,000	$1,236,235	2,900	1,379
2051	Year 24		$2,600,000	$0	$2,600,000	$1,206,940	2,900	1,346
2052	Year 25		$2,600,000	$0	$2,600,000	$1,178,340	2,900	1,314
2053	Year 26		$2,600,000	$0	$2,600,000	$1,150,417	2,900	1,283
2054	Year 27		$2,600,000	$0	$2,600,000	$1,123,156	2,900	1,253
2055	Year 28		$2,600,000	$0	$2,600,000	$1,096,541	2,900	1,223
2056	Year 29		$2,600,000	$0	$2,600,000	$1,070,557	2,900	1,194
2057	Year 30		$2,600,000	$0	$2,600,000	$1,045,188	2,900	1,166
2058	Year 31		$2,600,000	$0	$2,600,000	$1,020,421	2,900	1,138
2059	Year 32		$2,600,000	$0	$2,600,000	$996,240	2,900	1,111
2060	Year 33		$2,600,000	$0	$2,600,000	$972,632	2,900	1,085
2061	Year 34		$2,600,000	$0	$2,600,000	$949,584	2,900	1,059
2062	Year 35		$2,600,000	$0	$2,600,000	$927,082	2,900	1,034
2063	Year 36		$2,600,000	$0	$2,600,000	$905,113	2,900	1,010
2064	Year 37		$2,600,000	$0	$2,600,000	$883,665	2,900	986
2065	Year 38		$2,600,000	$0	$2,600,000	$862,725	2,900	962
2066	Year 39		$2,600,000	$0	$2,600,000	$842,282	2,900	939
2067	Year 40		$2,600,000	$1,034,018	$3,634,018	$1,149,359	2,900	917
2068	Year 41		$2,600,000	$0	$2,600,000	$802,836	2,900	895
2069	Year 42		$2,600,000	$0	$2,600,000	$783,811	2,900	874
2070	Year 43		$2,600,000	$0	$2,600,000	$765,238	2,900	854
2071	Year 44		$2,600,000	$0	$2,600,000	$747,104	2,900	833
2072	Year 45		$2,600,000	$0	$2,600,000	$729,400	2,900	814
2073	Year 46		$2,600,000	$0	$2,600,000	$712,116	2,900	794
2074	Year 47		$2,600,000	$0	$2,600,000	$695,241	2,900	775
2075	Year 48		$2,600,000	$0	$2,600,000	$678,766	2,900	757
2076	Year 49		$2,600,000	$0	$2,600,000	$662,682	2,900	739
2077	Year 50		$2,600,000	$0	$2,600,000	$646,978	2,900	722
2078	Year 51		$2,600,000	$0	$2,600,000	$631,647	2,900	705
2079	Year 52		$2,600,000	$0	$2,600,000	$616,679	2,900	688
2080	Year 53		$2,600,000	$0	$2,600,000	$602,066	2,900	672
2081	Year 54		$2,600,000	$0	$2,600,000	$587,799	2,900	656
2082	Year 55		$2,600,000	$0	$2,600,000	$573,870	2,900	640
2083	Year 56		$2,600,000	$0	$2,600,000	$560,271	2,900	625
2084	Year 57		$2,600,000	$0	$2,600,000	$546,995	2,900	610
2085	Year 58		$2,600,000	$0	$2,600,000	$534,033	2,900	596
2086	Year 59		$2,600,000	$0	$2,600,000	$521,378	2,900	582
2087	Year 60		$2,600,000	$1,034,365	$3,634,365	$711,529	2,900	568
2088	Year 61		$2,600,000	$513	$2,600,513	$497,059	2,900	554

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2089	Year 62		$2,600,000	$755	$2,600,755	$485,325	2,900	541
2090	Year 63		$2,600,000	$1,098	$2,601,098	$473,887	2,900	528
2091	Year 64		$2,600,000	$1,582	$2,601,582	$462,744	2,900	516
2092	Year 65		$2,600,000	$2,256	$2,602,256	$451,895	2,900	504
2093	Year 66		$2,600,000	$3,186	$2,603,186	$441,345	2,900	492
2094	Year 67		$2,600,000	$4,453	$2,604,453	$431,096	2,900	480
2095	Year 68		$2,600,000	$6,163	$2,606,163	$421,157	2,900	469
2096	Year 69		$2,600,000	$8,445	$2,608,445	$411,537	2,900	458
2097	Year 70		$2,600,000	$11,457	$2,611,457	$402,249	2,900	447
2098	Year 71		$2,600,000	$15,388	$2,615,388	$393,308	2,900	436
2099	Year 72		$2,600,000	$20,462	$2,620,462	$384,733	2,900	426
2100	Year 73		$2,600,000	$26,939	$2,626,939	$376,544	2,900	416
2101	Year 74		$2,600,000	$35,112	$2,635,112	$368,765	2,900	406
2102	Year 75		$2,600,000	$45,312	$2,645,312	$361,420	2,900	396
2103	Year 76		$2,600,000	$57,891	$2,657,891	$354,534	2,900	387
2104	Year 77		$2,600,000	$73,227	$2,673,227	$348,130	2,900	378
2105	Year 78		$2,600,000	$91,704	$2,691,704	$342,229	2,900	369
2106	Year 79		$2,600,000	$113,700	$2,713,700	$336,850	2,900	360
2107	Year 80		$2,600,000	$1,173,588	$3,773,588	$457,313	2,900	351
2108	Year 81		$2,600,000	$169,620	$2,769,620	$327,691	2,900	343
2109	Year 82		$2,600,000	$204,090	$2,804,090	$323,907	2,900	335
2110	Year 83		$2,600,000	$243,121	$2,843,121	$320,634	2,900	327
2111	Year 84		$2,600,000	$286,736	$2,886,736	$317,838	2,900	319
2112	Year 85		$2,600,000	$334,809	$2,934,809	$315,474	2,900	312
2113	Year 86		$2,600,000	$387,053	$2,987,053	$313,481	2,900	304
2114	Year 87		$2,600,000	$442,996	$3,042,996	$311,784	2,900	297
2115	Year 88		$2,600,000	$501,980	$3,101,980	$310,296	2,900	290
2116	Year 89		$2,600,000	$563,158	$3,163,158	$308,918	2,900	283
2117	Year 90		$2,600,000	$625,506	$3,225,506	$307,542	2,900	277
2118	Year 91		$2,600,000	$687,843	$3,287,843	$306,057	2,900	270
2119	Year 92		$2,600,000	$748,866	$3,348,866	$304,351	2,900	264
2120	Year 93		$2,600,000	$807,191	$3,407,191	$302,314	2,900	257
2121	Year 94		$2,600,000	$861,401	$3,461,401	$299,846	2,900	251
2122	Year 95		$2,600,000	$910,105	$3,510,105	$296,860	2,900	245
2123	Year 96		$2,600,000	$951,995	$3,551,995	$293,284	2,900	239
2124	Year 97		$2,600,000	$985,905	$3,585,905	$289,067	2,900	234
2125	Year 98		$2,600,000	$1,010,863	$3,610,863	$284,182	2,900	228
2126	Year 99		$2,600,000	$1,026,141	$3,626,141	$278,621	2,900	223
2127	Year 100		$2,600,000	$1,031,284	$3,631,284	$272,405	2,900	218

[1] ROCM lifecycle costs are placeholders based on the values reported in "Task 5 - Basis of Cost Estimated for ROCM Options FINAL (3-6-20)"by GHD, deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Table 1-9. Life-cycle cost for Morgan Hill Option 2 (GWR)

Morgan Hill - Option 2

Summary of Lifecycle Unit Costs ($/AF)

Time Horizon	Unit Costs, excluding ROC management	Unit Costs, excluding R&R and ROC management	ROCM Unit Costs Only	Unit Costs, including ROC management
100-Yr Lifecycle:	$ 5,400	$ 4,800	$ 100	$ 5,500
30-Yr Lifecycle:	$ 6,100	$ 5,600	$ 200	$ 6,300

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
	100-Yr Lifecycle:	**$75,000,000**	**$680,000,000**	**$170,000,000**	**$925,000,000**	**$315,000,000**	**190,000**	**59,000**
	30-Yr Lifecycle:	**$75,000,000**	**$205,000,000**	**$35,000,000**	**$315,000,000**	**$200,000,000**	**57,000**	**33,000**
2019				$0	$0	$0		
2020				$0	$0	$0		
2021				$0	$0	$0		
2022				$0	$0	$0		
2023				$0	$0	$0		
2024		$18,750,000		$0	$18,750,000	$16,631,258		
2025		$18,750,000		$0	$18,750,000	$16,237,152		
2026		$18,750,000		$0	$18,750,000	$15,852,386		
2027		$18,750,000		$0	$18,750,000	$15,476,737		
2028	Year 1		$6,800,000	$0	$6,800,000	$5,479,889	1,900	1,531
2029	Year 2		$6,800,000	$0	$6,800,000	$5,350,034	1,900	1,495
2030	Year 3		$6,800,000	$0	$6,800,000	$5,223,256	1,900	1,459
2031	Year 4		$6,800,000	$0	$6,800,000	$5,099,482	1,900	1,425
2032	Year 5		$6,800,000	$0	$6,800,000	$4,978,642	1,900	1,391
2033	Year 6		$6,800,000	$0	$6,800,000	$4,860,664	1,900	1,358
2034	Year 7		$6,800,000	$0	$6,800,000	$4,745,483	1,900	1,326
2035	Year 8		$6,800,000	$29,136	$6,829,136	$4,652,882	1,900	1,295
2036	Year 9		$6,800,000	$0	$6,800,000	$4,523,243	1,900	1,264
2037	Year 10		$6,800,000	$1,584,901	$8,384,901	$5,445,324	1,900	1,234
2038	Year 11		$6,800,000	$0	$6,800,000	$4,311,411	1,900	1,205
2039	Year 12		$6,800,000	$0	$6,800,000	$4,209,245	1,900	1,176
2040	Year 13		$6,800,000	$0	$6,800,000	$4,109,500	1,900	1,148
2041	Year 14		$6,800,000	$0	$6,800,000	$4,012,118	1,900	1,121
2042	Year 15		$6,800,000	$55,521	$6,855,521	$3,949,027	1,900	1,094
2043	Year 16		$6,800,000	$29,136	$6,829,136	$3,840,609	1,900	1,069
2044	Year 17		$6,800,000	$0	$6,800,000	$3,733,602	1,900	1,043
2045	Year 18		$6,800,000	$0	$6,800,000	$3,645,128	1,900	1,018
2046	Year 19		$6,800,000	$0	$6,800,000	$3,558,751	1,900	994

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2047	Year 20		$6,800,000	$4,750,373	$11,550,373	$5,901,595	1,900	971
2048	Year 21		$6,800,000	$0	$6,800,000	$3,392,088	1,900	948
2049	Year 22		$6,800,000	$0	$6,800,000	$3,311,707	1,900	925
2050	Year 23		$6,800,000	$0	$6,800,000	$3,233,230	1,900	903
2051	Year 24		$6,800,000	$29,136	$6,829,136	$3,170,139	1,900	882
2052	Year 25		$6,800,000	$25,540,259	$32,340,259	$14,656,853	1,900	861
2053	Year 26		$6,800,000	$0	$6,800,000	$3,008,783	1,900	841
2054	Year 27		$6,800,000	$0	$6,800,000	$2,937,485	1,900	821
2055	Year 28		$6,800,000	$0	$6,800,000	$2,867,877	1,900	801
2056	Year 29		$6,800,000	$0	$6,800,000	$2,799,917	1,900	782
2057	Year 30		$6,800,000	$2,184,682	$8,984,682	$3,611,801	1,900	764
2058	Year 31		$6,800,000	$0	$6,800,000	$2,668,792	1,900	746
2059	Year 32		$6,800,000	$3,617	$6,803,617	$2,606,937	1,900	728
2060	Year 33		$6,800,000	$25,519	$6,825,519	$2,553,354	1,900	711
2061	Year 34		$6,800,000	$0	$6,800,000	$2,483,528	1,900	694
2062	Year 35		$6,800,000	$0	$6,800,000	$2,424,677	1,900	677
2063	Year 36		$6,800,000	$0	$6,800,000	$2,367,220	1,900	661
2064	Year 37		$6,800,000	$0	$6,800,000	$2,311,124	1,900	646
2065	Year 38		$6,800,000	$0	$6,800,000	$2,256,359	1,900	630
2066	Year 39		$6,800,000	$0	$6,800,000	$2,202,890	1,900	616
2067	Year 40		$6,800,000	$5,625,214	$12,425,214	$3,929,819	1,900	601
2068	Year 41		$6,800,000	$25,519	$6,825,519	$2,107,605	1,900	587
2069	Year 42		$6,800,000	$0	$6,800,000	$2,049,968	1,900	573
2070	Year 43		$6,800,000	$0	$6,800,000	$2,001,391	1,900	559
2071	Year 44		$6,800,000	$0	$6,800,000	$1,953,965	1,900	546
2072	Year 45		$6,800,000	$55,521	$6,855,521	$1,923,238	1,900	533
2073	Year 46		$6,800,000	$0	$6,800,000	$1,862,457	1,900	520
2074	Year 47		$6,800,000	$0	$6,800,000	$1,818,323	1,900	508
2075	Year 48		$6,800,000	$3,617	$6,803,617	$1,776,179	1,900	496
2076	Year 49		$6,800,000	$25,519	$6,825,519	$1,739,672	1,900	484
2077	Year 50		$6,800,000	$32,343,133	$39,143,133	$9,740,292	1,900	473
2078	Year 51		$6,800,000	$0	$6,800,000	$1,652,000	1,900	462
2079	Year 52		$6,800,000	$0	$6,800,000	$1,612,853	1,900	451
2080	Year 53		$6,800,000	$0	$6,800,000	$1,574,634	1,900	440
2081	Year 54		$6,800,000	$0	$6,800,000	$1,537,320	1,900	430
2082	Year 55		$6,800,000	$0	$6,800,000	$1,500,891	1,900	419
2083	Year 56		$6,800,000	$3,617	$6,803,617	$1,466,104	1,900	409
2084	Year 57		$6,800,000	$0	$6,800,000	$1,430,601	1,900	400
2085	Year 58		$6,800,000	$25,519	$6,825,519	$1,401,942	1,900	390
2086	Year 59		$6,800,000	$0	$6,800,000	$1,363,604	1,900	381
2087	Year 60		$6,800,000	$5,304,577	$12,104,577	$2,369,811	1,900	372
2088	Year 61		$6,800,000	$394	$6,800,394	$1,299,819	1,900	363

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2089	Year 62		$6,800,000	$581	$6,800,581	$1,269,052	1,900	355
2090	Year 63		$6,800,000	$845	$6,800,845	$1,239,028	1,900	346
2091	Year 64		$6,800,000	$4,834	$6,804,834	$1,210,377	1,900	338
2092	Year 65		$6,800,000	$1,736	$6,801,736	$1,181,157	1,900	330
2093	Year 66		$6,800,000	$27,969	$6,827,969	$1,157,615	1,900	322
2094	Year 67		$6,800,000	$3,426	$6,803,426	$1,126,121	1,900	314
2095	Year 68		$6,800,000	$4,740	$6,804,740	$1,099,648	1,900	307
2096	Year 69		$6,800,000	$6,497	$6,806,497	$1,073,867	1,900	300
2097	Year 70		$6,800,000	$1,639,557	$8,439,557	$1,299,964	1,900	293
2098	Year 71		$6,800,000	$11,837	$6,811,837	$1,024,379	1,900	286
2099	Year 72		$6,800,000	$19,357	$6,819,357	$1,001,209	1,900	279
2100	Year 73		$6,800,000	$20,722	$6,820,722	$977,679	1,900	272
2101	Year 74		$6,800,000	$52,529	$6,852,529	$958,962	1,900	266
2102	Year 75		$6,800,000	$31,374,788	$38,174,788	$5,215,694	1,900	260
2103	Year 76		$6,800,000	$44,533	$6,844,533	$912,986	1,900	253
2104	Year 77		$6,800,000	$56,329	$6,856,329	$892,887	1,900	247
2105	Year 78		$6,800,000	$70,543	$6,870,543	$873,536	1,900	242
2106	Year 79		$6,800,000	$87,464	$6,887,464	$854,937	1,900	236
2107	Year 80		$6,800,000	$5,686,735	$12,486,735	$1,513,241	1,900	230
2108	Year 81		$6,800,000	$130,481	$6,930,481	$819,988	1,900	225
2109	Year 82		$6,800,000	$156,996	$6,956,996	$803,620	1,900	219
2110	Year 83		$6,800,000	$212,540	$7,012,540	$790,841	1,900	214
2111	Year 84		$6,800,000	$220,572	$7,020,572	$772,985	1,900	209
2112	Year 85		$6,800,000	$257,553	$7,057,553	$758,643	1,900	204
2113	Year 86		$6,800,000	$297,740	$7,097,740	$744,883	1,900	199
2114	Year 87		$6,800,000	$340,775	$7,140,775	$731,641	1,900	195
2115	Year 88		$6,800,000	$389,765	$7,189,765	$719,204	1,900	190
2116	Year 89		$6,800,000	$433,210	$7,233,210	$706,404	1,900	186
2117	Year 90		$6,800,000	$2,540,294	$9,340,294	$890,569	1,900	181
2118	Year 91		$6,800,000	$554,643	$7,354,643	$684,626	1,900	177
2119	Year 92		$6,800,000	$576,066	$7,376,066	$670,350	1,900	173
2120	Year 93		$6,800,000	$620,932	$7,420,932	$658,445	1,900	169
2121	Year 94		$6,800,000	$662,634	$7,462,634	$646,455	1,900	165
2122	Year 95		$6,800,000	$700,100	$7,500,100	$634,305	1,900	161
2123	Year 96		$6,800,000	$735,941	$7,535,941	$622,233	1,900	157
2124	Year 97		$6,800,000	$758,408	$7,558,408	$609,299	1,900	153
2125	Year 98		$6,800,000	$777,608	$7,577,608	$596,372	1,900	150
2126	Year 99		$6,800,000	$814,878	$7,614,878	$585,104	1,900	146
2127	Year 100		$6,800,000	$39,510,691	$46,310,691	$3,474,049	1,900	143

[1] ROCM lifecycle costs are placeholders based on the values reported in "Task 5 - Basis of Cost Estimated for ROCM Options FINAL (3-6-20)"by GHD, deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Table 1-10. Life-cycle cost for Morgan Hill Option 3 (SWA)

Morgan Hill - Option 3

Summary of Lifecycle Unit Costs ($/AF)				
Time Horizon	Unit Costs, excluding ROC management	Unit Costs, excluding R&R and ROC management	ROCM Unit Costs Only	Unit Costs, including ROC management
100-Yr Lifecycle:	$ 6,000	$ 5,300	$ 100	$ 6,100
30-Yr Lifecycle:	$ 7,000	$ 6,500	$ 200	$ 7,200

[1] ROC management costs included for context only. ROC management lifecycle costs are calculated in separate report by GHD and are subject to change based on report revisions.

Lifecycle Cost Calculations, excluding ROC management								
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
	100-Yr Lifecycle:	$95,000,000	$730,000,000	$185,000,000	$1,010,000,000	$350,000,000	190,000	59,000
	30-Yr Lifecycle:	$95,000,000	$220,000,000	$40,000,000	$355,000,000	$230,000,000	57,000	33,000
2019				$0	$0	$0		
2020				$0	$0	$0		
2021				$0	$0	$0		
2022				$0	$0	$0		
2023				$0	$0	$0		
2024		$23,750,000		$0	$23,750,000	$21,066,260		
2025		$23,750,000		$0	$23,750,000	$20,567,059		
2026		$23,750,000		$0	$23,750,000	$20,079,688		
2027		$23,750,000		$0	$23,750,000	$19,603,866		
2028	Year 1		$7,300,000	$0	$7,300,000	$5,882,823	1,900	1,531
2029	Year 2		$7,300,000	$0	$7,300,000	$5,743,419	1,900	1,495
2030	Year 3		$7,300,000	$0	$7,300,000	$5,607,319	1,900	1,459
2031	Year 4		$7,300,000	$0	$7,300,000	$5,474,444	1,900	1,425
2032	Year 5		$7,300,000	$0	$7,300,000	$5,344,718	1,900	1,391
2033	Year 6		$7,300,000	$0	$7,300,000	$5,218,066	1,900	1,358
2034	Year 7		$7,300,000	$0	$7,300,000	$5,094,415	1,900	1,326
2035	Year 8		$7,300,000	$29,136	$7,329,136	$4,993,546	1,900	1,295
2036	Year 9		$7,300,000	$0	$7,300,000	$4,855,834	1,900	1,264
2037	Year 10		$7,300,000	$1,775,914	$9,075,914	$5,894,082	1,900	1,234
2038	Year 11		$7,300,000	$0	$7,300,000	$4,628,427	1,900	1,205
2039	Year 12		$7,300,000	$0	$7,300,000	$4,518,748	1,900	1,176
2040	Year 13		$7,300,000	$0	$7,300,000	$4,411,669	1,900	1,148
2041	Year 14		$7,300,000	$0	$7,300,000	$4,307,127	1,900	1,121
2042	Year 15		$7,300,000	$55,521	$7,355,521	$4,237,045	1,900	1,094
2043	Year 16		$7,300,000	$29,136	$7,329,136	$4,121,802	1,900	1,069
2044	Year 17		$7,300,000	$0	$7,300,000	$4,008,132	1,900	1,043
2045	Year 18		$7,300,000	$0	$7,300,000	$3,913,152	1,900	1,018
2046	Year 19		$7,300,000	$0	$7,300,000	$3,820,424	1,900	994

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2047	Year 20		$7,300,000	$5,454,829	$12,754,829	$6,517,005	1,900	971
2048	Year 21		$7,300,000	$0	$7,300,000	$3,641,506	1,900	948
2049	Year 22		$7,300,000	$0	$7,300,000	$3,555,215	1,900	925
2050	Year 23		$7,300,000	$0	$7,300,000	$3,470,968	1,900	903
2051	Year 24		$7,300,000	$29,136	$7,329,136	$3,402,242	1,900	882
2052	Year 25		$7,300,000	$26,576,825	$33,876,825	$15,353,237	1,900	861
2053	Year 26		$7,300,000	$0	$7,300,000	$3,230,017	1,900	841
2054	Year 27		$7,300,000	$0	$7,300,000	$3,153,477	1,900	821
2055	Year 28		$7,300,000	$0	$7,300,000	$3,078,750	1,900	801
2056	Year 29		$7,300,000	$0	$7,300,000	$3,005,794	1,900	782
2057	Year 30		$7,300,000	$2,407,531	$9,707,531	$3,902,383	1,900	764
2058	Year 31		$7,300,000	$0	$7,300,000	$2,865,027	1,900	746
2059	Year 32		$7,300,000	$3,617	$7,303,617	$2,798,521	1,900	728
2060	Year 33		$7,300,000	$25,519	$7,325,519	$2,740,399	1,900	711
2061	Year 34		$7,300,000	$0	$7,300,000	$2,666,140	1,900	694
2062	Year 35		$7,300,000	$0	$7,300,000	$2,602,962	1,900	677
2063	Year 36		$7,300,000	$0	$7,300,000	$2,541,280	1,900	661
2064	Year 37		$7,300,000	$0	$7,300,000	$2,481,060	1,900	646
2065	Year 38		$7,300,000	$0	$7,300,000	$2,422,267	1,900	630
2066	Year 39		$7,300,000	$0	$7,300,000	$2,364,868	1,900	616
2067	Year 40		$7,300,000	$6,329,670	$13,629,670	$4,310,762	1,900	601
2068	Year 41		$7,300,000	$25,519	$7,325,519	$2,261,996	1,900	587
2069	Year 42		$7,300,000	$0	$7,300,000	$2,200,701	1,900	573
2070	Year 43		$7,300,000	$0	$7,300,000	$2,148,552	1,900	559
2071	Year 44		$7,300,000	$0	$7,300,000	$2,097,638	1,900	546
2072	Year 45		$7,300,000	$55,521	$7,355,521	$2,063,507	1,900	533
2073	Year 46		$7,300,000	$0	$7,300,000	$1,999,402	1,900	520
2074	Year 47		$7,300,000	$0	$7,300,000	$1,952,023	1,900	508
2075	Year 48		$7,300,000	$3,617	$7,303,617	$1,906,711	1,900	496
2076	Year 49		$7,300,000	$25,519	$7,325,519	$1,867,110	1,900	484
2077	Year 50		$7,300,000	$33,833,037	$41,133,037	$10,235,455	1,900	473
2078	Year 51		$7,300,000	$0	$7,300,000	$1,773,471	1,900	462
2079	Year 52		$7,300,000	$0	$7,300,000	$1,731,445	1,900	451
2080	Year 53		$7,300,000	$0	$7,300,000	$1,690,416	1,900	440
2081	Year 54		$7,300,000	$0	$7,300,000	$1,650,359	1,900	430
2082	Year 55		$7,300,000	$0	$7,300,000	$1,611,250	1,900	419
2083	Year 56		$7,300,000	$3,617	$7,303,617	$1,573,849	1,900	409
2084	Year 57		$7,300,000	$0	$7,300,000	$1,535,793	1,900	400
2085	Year 58		$7,300,000	$25,519	$7,325,519	$1,504,641	1,900	390
2086	Year 59		$7,300,000	$0	$7,300,000	$1,463,869	1,900	381
2087	Year 60		$7,300,000	$6,010,471	$13,310,471	$2,605,898	1,900	372
2088	Year 61		$7,300,000	$638	$7,300,638	$1,395,435	1,900	363

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2089	Year 62		$7,300,000	$937	$7,300,937	$1,362,424	1,900	355
2090	Year 63		$7,300,000	$1,363	$7,301,363	$1,330,216	1,900	346
2091	Year 64		$7,300,000	$5,582	$7,305,582	$1,299,445	1,900	338
2092	Year 65		$7,300,000	$2,801	$7,302,801	$1,268,170	1,900	330
2093	Year 66		$7,300,000	$29,474	$7,329,474	$1,242,640	1,900	322
2094	Year 67		$7,300,000	$5,529	$7,305,529	$1,209,230	1,900	314
2095	Year 68		$7,300,000	$7,652	$7,307,652	$1,180,919	1,900	307
2096	Year 69		$7,300,000	$10,487	$7,310,487	$1,153,382	1,900	300
2097	Year 70		$7,300,000	$1,866,544	$9,166,544	$1,411,943	1,900	293
2098	Year 71		$7,300,000	$19,106	$7,319,106	$1,100,663	1,900	286
2099	Year 72		$7,300,000	$29,023	$7,329,023	$1,076,037	1,900	279
2100	Year 73		$7,300,000	$33,450	$7,333,450	$1,051,173	1,900	272
2101	Year 74		$7,300,000	$69,117	$7,369,117	$1,031,255	1,900	266
2102	Year 75		$7,300,000	$32,560,102	$39,860,102	$5,445,953	1,900	260
2103	Year 76		$7,300,000	$71,881	$7,371,881	$983,328	1,900	253
2104	Year 77		$7,300,000	$90,923	$7,390,923	$962,507	1,900	247
2105	Year 78		$7,300,000	$113,865	$7,413,865	$942,615	1,900	242
2106	Year 79		$7,300,000	$141,177	$7,441,177	$923,669	1,900	236
2107	Year 80		$7,300,000	$6,426,564	$13,726,564	$1,663,494	1,900	230
2108	Year 81		$7,300,000	$210,612	$7,510,612	$888,627	1,900	225
2109	Year 82		$7,300,000	$253,410	$7,553,410	$872,513	1,900	219
2110	Year 83		$7,300,000	$327,395	$7,627,395	$860,181	1,900	214
2111	Year 84		$7,300,000	$356,029	$7,656,029	$842,950	1,900	209
2112	Year 85		$7,300,000	$415,721	$7,715,721	$829,392	1,900	204
2113	Year 86		$7,300,000	$480,590	$7,780,590	$816,546	1,900	199
2114	Year 87		$7,300,000	$550,052	$7,850,052	$804,313	1,900	195
2115	Year 88		$7,300,000	$626,908	$7,926,908	$792,942	1,900	190
2116	Year 89		$7,300,000	$699,254	$7,999,254	$781,217	1,900	186
2117	Year 90		$7,300,000	$3,057,366	$10,357,366	$987,544	1,900	181
2118	Year 91		$7,300,000	$879,589	$8,179,589	$761,418	1,900	177
2119	Year 92		$7,300,000	$929,841	$8,229,841	$747,942	1,900	173
2120	Year 93		$7,300,000	$1,002,260	$8,302,260	$736,644	1,900	169
2121	Year 94		$7,300,000	$1,069,571	$8,369,571	$725,019	1,900	165
2122	Year 95		$7,300,000	$1,130,046	$8,430,046	$712,953	1,900	161
2123	Year 96		$7,300,000	$1,185,677	$8,485,677	$700,652	1,900	157
2124	Year 97		$7,300,000	$1,224,164	$8,524,164	$687,151	1,900	153
2125	Year 98		$7,300,000	$1,255,154	$8,555,154	$673,307	1,900	150
2126	Year 99		$7,300,000	$1,299,642	$8,599,642	$660,770	1,900	146
2127	Year 100		$7,300,000	$41,793,408	$49,093,408	$3,682,797	1,900	143

[1] ROCM lifecycle costs are placeholders based on the values reported in "Task 5 - Basis of Cost Estimated for ROCM Options FINAL (3-6-20)"by GHD, deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Cost estimates summary

Table 1-11. Overview of Capital and Annual O&M Costs for North County Portfolios and South County Reuse Options

Table no. in Appendix A-6	ID no.	Project element	Location or start point	End point	Diameter (in)	Flow capacity (mgd)	Horse-power (hp)	Length (LF)	Length (miles)	Annual Purified Water Yield, lower bound (AFY)[a]	Annual Purified Water Yield, upper bound (AFY)[a]	Total Capital[b] Cost	Estimated Annual O&M	Rounded Capital Cost[b]	Rounded Annual O&M
1a - PORTFOLIO SUMMARY															
Table D-12	AWPF-1a	AWPF	San José	--	--	24.0	--	--	--	--	--	$ 307,000,000	$ 13,700,000	$ 310,000,000	$ 13,700,000
Table D-13	PL-1	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	--	--	2,000	0.4	--	--	$ 6,400,000	$ 3,000	$ 320,000,000	$ 2,300,000
Table D-14	PL-2	Purified Water Pipeline	San José AWPF	LGRP	48	--	--	95,490	18.1	--	--	$ 264,000,000	$ 156,000		
Table D-15	PS-1	Pump Station	San José AWPF	LGRP	--	24.0	2,877	--	--	--	--	$ 27,800,000	$ 1,673,000		
Table D-16	LGRP-1	LGRP Site Improvements	--	--	--	--	--	--	--	--	--	$ 15,000,000	$ 400,000		
--	PL Easements	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	97,490	18.5	--	--	$ 3,100,000	$ -		
--	ROCM-1a	ROCM strategy	--	--	--	--	--	--	--	--	--	$ 18,600,000	$ 1,753,000	$ 20,000,000	$ 1,800,000
--	Source water	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	--	--	19,000	24,000	$ -	$ 2,400,000	$ -	$ 2,400,000
TOTAL - Excluding ROCM														$ 630,000,000	$ 18,400,000
TOTAL														**$ 650,000,000**	**$ 20,200,000**
1b - PORTFOLIO SUMMARY															
Table D-17	AWPF-1b	AWPF	San José	--	--	24.0	--	--	--	--	--	$ 369,000,000	$ 13,800,000	$ 370,000,000	$ 13,800,000
Table D-18	PL-1	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	--	--	2,000	0.4	--	--	$ 6,400,000	$ 3,000	$ 245,000,000	$ 2,700,000
Table D-19	PL-4	Purified Water Pipeline	San José AWPF	Penitencia WTP	48	--	--	47,100	8.9	--	--	$ 135,100,000	$ 77,000		
Table D-20	PS-2	Pump Station	San José AWPF	Penitencia WTP	--	24.0	3,977	--	--	--	--	$ 36,560,000	$ 2,287,000		
Table D-21	PEN-1	Penitencia Site Improvements	--	--	--	--	--	--	--	--	--	$ 55,000,000	$ 300,000		
--	PL Easements	Penitencia Site Improvements	--	--	--	--	--	49,100	9.3	--	--	$ 10,900,000	$ -		
--	ROCM-1b	ROCM strategy	--	--	--	--	--	--	--	--	--	$ 18,600,000	$ 1,753,000	$ 20,000,000	$ 1,800,000
--	Source water	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	--	--	19,800	24,000	$ -	$ 2,400,000	$ -	$ 2,400,000
TOTAL - Excluding ROCM														$ 615,000,000	$ 18,900,000
TOTAL														**$ 635,000,000**	**$ 20,700,000**
1c - PORTFOLIO SUMMARY															
Table D-22	AWPF-1c/d	AWPF	San José	--	--	24.0	--	--	--	--	--	$ 391,000,000	$ 16,300,000	$ 395,000,000	$ 16,300,000
Table D-23	PL-1	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	--	--	2,000	0.4	--	--	$ 6,400,000	$ 3,000	$ 140,000,000	$ 2,700,000
Table D-24	PL-40	Effluent Pipeline	SJ/SC RWF	San José AWPF	36	--	--	20,800	3.9	--	--	$ 42,000,000	$ 34,000		
Table D-25	PL-41	Purified Water Pipeline	San José AWPF	Penitencia WTP	24	--	--	24,700	4.7	--	--	$ 32,000,000	$ 40,000		
Table D-26	PS-14	Pump Station	San José AWPF	Penitencia WTP	--	24.0	2,500	--	--	--	--	$ 33,240,000	$ 1,919,000		
Table D-27	PS-15	Penitencia Site Improvements	--	--	--	12.0	890	--	--	--	--	$ 15,670,000	$ 703,800		
--	PL Easements				--	--	--	47,500	8.6	--	--	$ 10,500,000	$ -		
--	ROCM-1c	ROCM strategy	--	--	--	--	--	--	--	--	--	$ 18,600,000	$ 1,753,000	$ 20,000,000	$ 1,800,000
--	Source water	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	--	--	24,000	24,000	$ -	$ 2,400,000	$ -	$ 2,400,000
TOTAL - Excluding ROCM														$ 535,000,000	$ 21,400,000
TOTAL														**$ 555,000,000**	**$ 23,200,000**
1d - PORTFOLIO SUMMARY															
Table D-22	AWPF-1c/d	AWPF	San José	--	--	24.0	--	--	--	--	--	$ 391,000,000	$ 16,300,000	$ 395,000,000	$ 16,300,000
Table D-23	PL-1	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	--	--	2,000	0.4	--	--	$ 6,400,000	$ 3,000	$ 190,000,000	$ 2,800,000
Table D-28	PL-42	Effluent Pipeline	SJ/SC RWF	San José AWPF	36	--	--	43,100	8.2	--	--	$ 86,000,000	$ 70,000		
Table D-29	PL-43	Purified Water Pipeline	San José AWPF	Penitencia WTP	24	--	--	24,700	4.7	--	--	$ 32,000,000	$ 40,000		
Table D-30	PS-16	Pump Station	San José AWPF	Penitencia WTP	--	24.0	2,500	--	--	--	--	$ 33,240,000	$ 1,919,000		
Table D-31	PS-17	Penitencia Site Improvements	--	--	--	12.0	890	--	--	--	--	$ 15,670,000	$ 703,800		
--	PL Easements	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	69,800	12.8	--	--	$ 15,500,000	$ -		
--	ROCM-1d	ROCM strategy	--	--	--	--	--	--	--	--	--	$ 18,600,000	$ 1,753,000	$ 20,000,000	$ 1,800,000
--	Source water	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	--	--	24,000	24,000	$ -	$ 2,400,000	$ -	$ 2,400,000
TOTAL - Excluding ROCM														$ 585,000,000	$ 21,500,000
TOTAL														**$ 605,000,000**	**$ 23,300,000**

Table no. in Appendix A-6	ID no.	Project element	Location or start point	End point	Diameter (in)	Flow capacity (mgd)	Horse-power (hp)	Length (LF)	Length (miles)	Annual Purified Water Yield, lower bound (AFY)[a]	Annual Purified Water Yield, upper bound (AFY)[a]	Total Capital[b] Cost	Estimated Annual O&M	Rounded Capital Cost[b]	Rounded Annual O&M
2a - PORTFOLIO SUMMARY															
Table D-32	AWPF-2a	AWPF	Palo Alto	--	--	24.5	--	--	--	--	--	$ 290,000,000	$ 13,570,000	$ 290,000,000	$ 13,600,000
Table D-33	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	--	--	15,150	2.9	--	--	$ 29,400,000	$ 25,000	$ 445,000,000	$ 3,500,000
Table D-34	PL-6	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36	--	--	38,820	7.4	--	--	$ 74,100,000	$ 63,000		
Table D-35	PL-7	Purified Water Pipeline	Palo Alto AWPF	LGRP	48	--	--	107,400	20.3	--	--	$ 284,400,000	$ 175,000		
Table D-36	PS-3	Pump Station	Palo Alto RWQCP	Palo Alto AWPF	--	17.3	508	--	--	--	--	$ 4,420,000	$ 354,000		
Table D-37	PS-4	Pump Station	Sunnyvale WPCP	Palo Alto AWPF	--	11.5	400	--	--	--	--	$ 4,420,000	$ 501,000		
Table D-38	PS-5	Pump Station	Palo Alto AWPF	LGRP	--	24.0	2,877	--	--	--	--	$ 27,800,000	$ 1,957,000		
Table D-39	LGRP-1	LGRP Site Improvements	--	--	--	--	--	--	--	--	--	$ 15,000,000	$ 400,000		
--	PL Easements	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	161,370	30.6	--	--	$ 5,200,000	$ -		
--	ROCM-2a	ROCM strategy	--	--	--	--	--	--	--	--	--	$ 34,400,000	$ 1,541,000	$ 35,000,000	$ 1,600,000
--	Source water	Purchased supply for reuse[c]	PA RWQCP and SV WPCP	--	--	--	--	--	--	17,000	23,000	$ -	$ 2,300,000	$ -	$ 2,300,000
TOTAL - Excluding ROCM														$ 735,000,000	$ 19,400,000
TOTAL														**$ 770,000,000**	**$ 21,000,000**
2b - PORTFOLIO SUMMARY															
Table D-40	AWPF-2b	AWPF	Sunnyvale	--	--	24.5	--	--	--	--	--	$ 304,000,000	$ 13,530,000	$ 350,000,000	$ 13,600,000
--	Recycle Hill Site Prep				--	24.5	--	--	--	--	--	$ 43,500,000	$ -		
Table D-41	PL-8	Effluent Pipeline	Palo Alto RWQCP	Sunnyvale AWPF	36	--	--	52,950	10.0	--	--	$ 102,700,000	$ 86,000	$ 405,000,000	$ 2,700,000
Table D-42	PL-9	Purified Water Pipeline	Sunnyvale AWPF	LGRP	48	--	--	90,230	17.1	--	--	$ 249,900,000	$ 147,000		
Table D-43	PS-6	Pump Station	Palo Alto RWQCP	Sunnyvale AWPF	--	17.3	508	--	--	--	--	$ 4,420,000	$ 354,000		
Table D-44	PS-7	Pump Station	Sunnyvale AWPF	LGRP	--	24.0	2,877	--	--	--	--	$ 27,800,000	$ 1,673,000		
Table D-45	LGRP-1	LGRP Site Improvements	--	--	--	--	--	--	--	--	--	$ 15,000,000	$ 400,000		
--	PL Easements	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	143,180	27.1	--	--	$ 4,600,000	$ -		
--	ROCM-2b	ROCM strategy	--	--	--	--	--	--	--	--	--	$ 36,900,000	$ 1,590,000	$ 40,000,000	$ 1,600,000
--	Source water	Purchased supply for reuse[c]	PA RWQCP and SV WPCP	--	--	--	--	--	--	17,000	23,000	$ -	$ 2,300,000	$ -	$ 2,300,000
TOTAL - Excluding ROCM														$ 755,000,000	$ 18,600,000
TOTAL														**$ 795,000,000**	**$ 20,200,000**
4 - PORTFOLIO SUMMARY															
Table D-46	AWPF-4 (1 of 2)	AWPF	Palo Alto	--	--	14.0	--	--	--	--	--	$ 195,000,000	$ 8,420,000	$ 195,000,000	$ 8,500,000
Table D-47	AWPF-4 (2 of 2)	AWPF	Sunnyvale	--	--	10.5	--	--	--	--	--	$ 161,000,000	$ 6,390,000	$ 205,000,000	$ 6,400,000
--	Recycle Hill Site Prep				--	24.5	--	--	--	--	--	$ 43,500,000	$ -		
Table D-48	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	--	--	15,150	2.9	--	--	$ 29,400,000	$ 25,000	$ 375,000,000	$ 2,900,000
Table D-49	PL-10	Purified Water Pipeline	Palo Alto AWPF	Joint Purified Water Pipeline	36	--	--	34,500	6.5	--	--	$ 67,100,000	$ 56,000		
Table D-50	PL-11	Purified Water Pipeline	Joint Purified Water Pipeline	LGRP	48	--	--	72,500	13.7	--	--	$ 188,500,000	$ 118,000		
Table D-51	PL-12	Purified Water Pipeline	Sunnyvale AWPF	Joint Purified Water Pipeline	36	--	--	11,400	2.2	--	--	$ 22,800,000	$ 19,000		
Table D-52	PS-3	Pump Station	Palo Alto RWQCP	Palo Alto AWPF	--	17.3	508	--	--	--	--	$ 4,420,000	$ 354,000		
Table D-53	PS-9	Pump Station	Palo Alto AWPF	LGRP	--	14.0	1,650	--	--	--	--	$ 20,870,000	$ 982,000		
Table D-54	PS-10	Pump Station	Sunnyvale AWPF	LGRP	--	10.0	1,400	--	--	--	--	$ 18,820,000	$ 875,000		
Table D-55	LGRP-1	LGRP Site Improvements	--	--	--	--	--	--	--	--	--	$ 15,000,000	$ 400,000		
--	PL Easements	Purchased supply for reuse[c]	SV WPCP	--	--	--	--	133,550	25.3	--	--	$ 4,300,000	$ -		
--	ROCM-4	ROCM strategy	--	--	--	--	--	--	--	--	--	$ 56,700,000	$ 1,609,000	$ 60,000,000	$ 1,700,000
--	Source water	Purchased supply for reuse[c]	PA RWQCP	--	--	--	--	--	--	11,700	13,200	$ -	$ 1,320,000	$ -	$ 1,400,000
--	Source water	Purchased supply for reusec	SV WPCP	--	--	--	--	--	--	5,500	9,800	$ -	$ 980,000	$ -	$ 1,000,000
Subtotal - Palo Alto components only (Excluding ROCM)														$ 525,000,000	$ 11,700,000
Subtotal - Remaining Sunnyvale components (Excluding ROCM)														$ 205,000,000	$ 8,300,000
TOTAL - Excluding ROCM														$ 775,000,000	$ 20,200,000
TOTAL														**$ 835,000,000**	**$ 21,900,000**

Table no. in Appendix A-6	ID no.	Project element	Location or start point	End point	Diameter (in)	Flow capacity (mgd)	Horse-power (hp)	Length (LF)	Length (miles)	Annual Purified Water Yield, lower bound (AFY)[a]	Annual Purified Water Yield, upper bound (AFY)[a]	Total Capital[b] Cost	Estimated Annual O&M	Rounded Capital Cost[b]	Rounded Annual O&M
Morgan Hill - Option 1 (NPR+ from SBWR)															
Table D-56	PL-35	Recycled Water	Metcalf Energy Center	Burnett Road at Monterey	16	5	--	31,500	6.0	--	—	$ 28,000,000	$ 51,000	$ 30,000,000	$ 100,000
--	PL Easements	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	31,500	6.0	--	—	$ 1,000,000	$ -		
--	NPR+ Distribution	Morgan Hill recycled water distribution system	Burnett Road at Monterey	--	--	--	--	86,700	16.4	--	—	$ 36,900,000	$ 678,000	$ 40,000,000	$ 700,000
--	Source water	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	--	--	2,900	2,900	$ -	$ 1,740,000	$ -	$ 1,800,000
TOTAL - Excluding ROCM														$ 70,000,000	$ 2,600,000
TOTAL														**$ 70,000,000**	**$ 2,600,000**
Morgan Hill - Option 2 (GWR)															
Table D-57	MH-Satellite	Satellite WWTP and AWPF	MH trunk line	--	--	2.5	--	--	--	--	—	$ 59,000,000	$ 6,700,000	$ 60,000,000	$ 6,700,000
Table D-58	PS-13	Purified Water	MH AWPF	San Pedro	--	2.1	78	--	--	--	—	$ 1,075,000	$ 45,177	$ 15,000,000	$ 100,000
Table D-59	PL-25	Purified Water	MH AWPF	San Pedro	16	--	--	14,600	2.8	--	—	$ 13,200,000	$ 24,000		
--	PL Easements	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	14,600	2.8	--	—	$ 500,000	$ -		
--	ROCM-MH	ROCM strategy	--	--	--	--	--	--	--	--	—	$ 48,700,000	$ 95,000	$ 50,000,000	$ 100,000
--	Source water	Purchased supply for reuse[d]	MH trunk line	--	--	--	--	--	--	1,900	1,900	$ -	$ -	$ -	$ -
TOTAL - Excluding ROCM														$ 75,000,000	$ 6,800,000
TOTAL														**$ 125,000,000**	**$ 6,900,000**
Morgan Hill - Option 3 (SWA)															
Table D-60	MH-Satellite	Satellite WWTP and AWPF	MH trunk line	--	--	2.5	--	--	--	--	—	$ 59,000,000	$ 6,700,000	$ 60,000,000	$ 6,700,000
Table D-61	PS-11	Purified Water	MH AWPF	Booster PS	--	2.1	279	--	--	--	—	$ 3,000,000	$ 346,000	$ 35,000,000	$ 600,000
Table D-62	PS-12	Purified Water	Booster PS	Anderson	--	2.1	218	--	--	--	—	$ 2,000,000	$ 124,736		
Table D-63	PL-26	Purified Water	MH AWPF	Anderson	16	--	--	29,400	5.6	--	—	$ 25,900,000	$ 48,000		
--	PL Easements	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	29,400	5.6	--	—	$ 900,000	$ -		
--	ROCM-MH	ROCM strategy	--	--	--	--	--	--	--	--	—	$ 48,700,000	$ 95,000	$ 50,000,000	$ 100,000
--	Source water	Purchased supply for reuse[d]	MH trunk line	--	--	--	--	--	--	1,900	1,900	$ -	$ -	$ -	$ -
TOTAL - Excluding ROCM														$ 95,000,000	$ 7,300,000
TOTAL														**$ 145,000,000**	**$ 7,400,000**
West County Treated Water Augmentation															
Table D-78	Westside TWA	AWPF	San José	--	--	24.0	--	--	--	--	—	$ 317,000,000	$ 16,050,000	$ 320,000,000	$ 16,100,000
Table D-33	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	--	--	15,150	2.9	--	—	$ 29,400,000	$ 25,000	$ 255,000,000	$ 2,600,000
Table D-34	PL-6	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36	--	--	38,820	7.4	--	—	$ 74,100,000	$ 63,000		
Table D-78	PL-44	Purified Water	Booster PS	Anderson	36	--	--	56,600	10.7	--	—	$ 111,000,000	$ 92,000		
Table D-36	PS-3	Purified Water	MH AWPF	Anderson	--	17.3	508	--	--	--	—	$ 4,420,000	$ 354,000		
Table D-37	PS-4	Purified Water	MH AWPF	Anderson	--	11.5	400	--	--	--	—	$ 4,420,000	$ 354,000		
Table D-79	PS-18	Purified Water	MH AWPF	Anderson	--	24.0	2,877	--	--	--	—	$ 29,180,000	$ 1,685,000		
--	PL Easements	Purchased supply for reuse[c]	SJ/SC RWF	--	--	--	--	110,570	20.9	--	—	$ 3,500,000	$ -		
--	ROCM	ROCM strategy	--	--	--	--	--	--	--	--	—	$ 34,400,000	$ 1,541,000	$ 35,000,000	$ 1,600,000
--	Source water	Purchased supply for reuse[d]	MH trunk line	--	--	--	--	--	--	23,400	23,400	$ -	$ 2,340,000	$ -	$ 2,400,000
TOTAL - Excluding ROCM														$ 575,000,000	$ 21,100,000
TOTAL														**$ 610,000,000**	**$ 22,700,000**
Alternative Alignments[e]															
Table D-68	PL-15	Purified Water	Moffett Field	Sunnyvale WPCP	36	--	--	17,800	3.4	--	—	$ 35,300,000	$ 29,000	$ 40,000,000	$ 100,000
Table D-69	PL-16	Purified Water	Sunnyvale WPCP	Arques (east)	36	--	--	30,300	5.7	--	—	$ 63,300,000	$ 49,000	$ 65,000,000	$ 100,000
Table D-70	PL-17	Purified Water	Sunnyvale WPCP	Arques (west)	36	--	--	11,400	2.2	--	—	$ 22,400,000	$ 19,000	$ 25,000,000	$ 100,000
Table D-71	PL-18	Purified Water	Moffett Field	Arques (west)	36	--	--	12,300	2.3	--	—	$ 24,400,000	$ 20,000	$ 25,000,000	$ 100,000
Table D-72	PL-19	Purified Water	Arques (west)	Arques (east)	36	--	--	12,100	2.3	--	—	$ 27,100,000	$ 20,000	$ 30,000,000	$ 100,000
Table D-73	PL-20	Purified Water	Arques (west)	Arques (east)	48	--	--	12,100	2.3	--	—	$ 33,300,000	$ 20,000	$ 35,000,000	$ 100,000
Table D-74	PL-31	Purified Water	Sunnyvale WPCP	LGRP	48	--	--	89,600	17.0	--	—	$ 250,300,000	$ 175,000	$ 255,000,000	$ 200,000
Table D-75	PL-32	Purified Water	Arques (west)	LGRP	48	--	--	72,500	13.7	--	—	$ 207,500,000	$ 118,000	$ 210,000,000	$ 200,000
Table D-76	PL-33	Purified Water	Palo Alto AWPF	Sunnyvale WPCP	36	--	--	38,820	7.4	--	—	$ 75,600,000	$ 63,000	$ 80,000,000	$ 100,000
Table D-77	PL-44	Purified Water	Palo Alto AWPF	Sunnyvale WPCP	36	--	--	56,600	10.7	--	—	$ 111,000,000	$ 92,000	$ 115,000,000	$ 100,000

a. Upper bound of yield is assumed in facility sizing for cost estimates and for the purposes of calculating source water costs. Lower bound reflects potential source water availability limitations or delivery point limitations (e.g. groundwater basin capacity). See Appendix A-2 for additional.

b. Assumes unit cost of source water purchased as supply for all portfolios is $100/AF. For Morgan Hill, Option 1 assumes a source water cost of $600/AF and Options 2 and 3 assume no cost for source water, due to exchange of equal volume of raw water for groundwater recharge.

c. Assumes that pipeline easement cost is $32/foot for all pipelines except Portfolios 1b, 1c, and 1d. Pipeline easements for Portfolios 1b, 1c, and 1d are assumed to cost $222/foot.

d. All costs reported in July 2019 dollars.

Portfolio 1a cost estimate details

Table 1-12. San José AWPF; 24 mgd for GWR (Portfolio 1a)

Focus: **Cost Summary**
Element: **AWPF (GWR)**
Capacity / Treatment: **24 mgd**
Location: **San José**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	131,000,000
Contingency - Treatment Facility	25%	$	33,000,000
Construction Cost Subtotal		**$**	**164,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	8,000,000
General Contractor Overhead and Profit	15%	$	25,000,000
Estimated Total Construction Cost		**$**	**197,000,000**
Owner's Reserve for Change Orders	15%	$	30,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	30,000,000
Construction Management	13%	$	26,000,000
Engineering Services During Construction	12%	$	24,000,000
Total Capital Cost		**$**	**307,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,500,000
Energy/Power	$	5,510,000
Chemicals	$	2,890,000
Labor	$	2,800,000
Total Annual O&M Cost	**$**	**13,700,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	172,000,000
30-yr Lifecycle (present value, $2019)	$	75,000,000

*See Attachment C, Basis of Cost for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	15,660,000
Annual O&M Cost		$	13,700,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	2,500,000
Total Annual Cost		**$**	**31,860,000**
Annual Yield	AF		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,730**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 - General Requirements	$	11,870,600	9%
Division 02 - Site Construction	$	-	0%
Division 03 - Concrete	$	5,799,500	4%
Division 04 - Masonry	$	-	0%
Division 05 - Metals	$	750,000	1%
Division 06 - Woods, Plastics, and Composites	$	-	0%
Division 07 - Thermal and Moisture Protection	$	-	0%
Division 08 - Doors and Windows	$	-	0%
Division 09 - Finishes	$	1,000,000	1%
Division 10 - Specialties	$	-	0%
Division 11 - Equipment	$	-	0%
Division 12 - Furnishings	$	-	0%
Division 13 - Special Construction	$	-	0%
Division 14 - Conveying Systems	$	-	0%
Division 15 - Mechanical	$	-	0%
Division 17 - Instrumentation	$	4,131,500	3%
Division 21 - Fire Suppression	$	-	0%
Division 22 - Plumbing	$	-	0%
Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)	$	-	0%
Division 26 - Electrical	$	16,525,900	13%
Division 27 - Communications	$	-	0%
Division 28 - Electronic Safety and Security	$	-	0%
Division 31 - Earthwork	$	5,184,800	4%
Division 32 - Exterior Improvements	$	155,300	0%
Division 33 - Utilities	$	-	0%
Division 40 - Process Integration	$	16,704,800	13%
Division 41 - Material Processing and Handling Equipment	$		0%
Division 42 - Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	$	20,034,700	15%
Division 44 - Pollution and Waste Control Equipment	$	-	0%
Division 46 - Water and Wastewater Equipment	$	48,419,400	37%
TOTAL	**$**	**131,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements		Mobilization		10%	LS			$ 118,705,900	10% of Divisions 2-47	$ 11,870,600	
Division 31 – Earthwork		Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200	
Division 31 – Earthwork		Strip Topsoil		37,534	SY		$ 0.85			$ 32,000	
Division 31 – Earthwork		Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400	
Division 31 – Earthwork		Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here
Division 31 – Earthwork		Excavation		16,556	CY		$ 11.78			$ 195,100	
Division 31 – Earthwork		Compaction		18,767	CY		$ 0.89			$ 16,800	
Division 31 – Earthwork		Grading		37,534	SY		$ 1.18			$ 44,300	
Division 31 – Earthwork		Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork		Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		12,711	CY		$ 58.49			$ 743,500	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		6,800	SY		$ 4.63			$ 31,500	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		162	CY		$ 645		See Site Work and Concrete Tab	$ 104,700	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
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Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 52.94			$ 155,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)		10	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps		4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps		4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters		3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Calcium Chloride Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps		4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 219		245' x 345'; furnished and installed	$ 18,475,300	Process Building

Brown AND Caldwell

Focus:	**Cost Inputs and R&R**	Date:	2/5/2020
Aspect:	**AWPF (GWR)**	BC Project Number:	151772
Capacity:	**24 mgd**	Estimate Version Number:	2.0
Location:	**San José**	Prepared by:	R. Guillen
		Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)		2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)		2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)		2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)		2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)		2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)		2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Calcium Chloride Tank (Carbon Steel, Vert.)		2	EA	$ 120,000			Assumes 30 day storage	$ 240,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)		2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 - Process Integration	Mechanical	Piping allowance		30%	% of			$48,419,400	30% of Equipment Costs	$ 14,525,900	
Division 40 - Process Integration	Mechanical	Valve allowance		5%	% of			$14,525,900	5% of Piping Allowance	$ 726,300	
Division 40 - Process Integration	Mechanical	Fitting allowance		5%	% of			$14,525,900	5% of Piping Allowance	$ 726,300	
Division 40 - Process Integration	Mechanical	Supports allowance		5%	% of			$14,525,900	5% of Piping Allowance	$ 726,300	
Division 26 - Electrical	Electrical	Electrical Allowance		30%	% of			$48,419,400	30% of Equipment Costs	$ 14,525,900	
Division 17 - Instrumentation	I&C	I&C Allowance		25%	% of			$16,525,900	25% of Electrical Costs	$ 4,131,500	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,750,400	2% of Pumping Equipment Cost	$ 35,100	
O&M	Consumables	Electrical Consumables		2%	% of			$ 16,525,900	2% of Electrical Cost	$ 330,600	

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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 4,131,500	2% of Instrumentation & Controls Cost	$ 82,700	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,764,439	kWh		$ 0.10			$ 182,600	
O&M	Power	Waste Equalization Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Calcium Chloride		240,000	gal		$ 0.54		Costs based on Expedited Purified Water Program Estimates	$ 130,700	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		6240	hours/yr		$ 163.20			$ 1,018,400	Assumes three plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		4160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		4160	hours/yr		$ 172.27			$ 716,700	Assumes two control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 1-13. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolio 1a)

HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PL-1. Effluent PL from SJ/SC RWF to San José AWPF**

Diam **60 inch**
Length **2,000 feet**

Date: 2/4/2020
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	200,000	
2 - Sitework	$	2,600,000	
Raw Construction Subtotal	**$**	**2,800,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	700,000	
		Construction Cost Subtotal	**$**	**3,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	500,000	
		Total Construction Cost	**$**	**4,200,000**	
	15%	Owner's Reserve for Change Orders	$	600,000	
	15%	Engineering Services (Design)	$	600,000	
	13%	Construction Management	$	500,000	
	12%	Engineering Services During Construction	$	500,000	
		TOTAL CAPITAL COST	**$**	**6,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 200,000**	
	Traffic Control (Heavy Urban)	7%	60	2,000	LS	$ 84.00	$ 200,000	7% of Divisions 2-17
			60					
2 - Sitework							**$ 2,600,000**	
	60" Open cut pipeline		60	2,000	LF	$ 1,200	$ 2,400,000	
	60" Bore and Jack Pipeline & Casing		60	-	LF	$ 3,120	$ -	
	60" HDD Pipeline		60	-	LF	$ 1,680	$ -	
	60" Microtunnel Pipeline & Casing		60		LF	$ 4,200	$ -	
	Sheeting and Shorting	7%	60	2,000	LF	$ 84.00	$ 200,000	
	Potholing (Heavy Urban)	2%	60	2,000	LF	$ 24.00	$ -	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 3,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$ -	
Annual Inspection and Pipeline Maintenance	2,000	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
TOTAL ANNUAL O&M COSTS				**$ 3,000**	

Table 1-14. PL-2, 48-inch purified water pipeline from San José AWPF to Los Gatos Recharge Ponds (LGRP) (Portfolio 1a)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	1/30/2020
				Project Number:	437-001-105
Aspect:	**PL-2. Purified water PL from San José AWPF to LGRP**	**Diam**	**48 inch**	Prepared By:	I Wald
		Length	**95,490 feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 6,100,000	
2 - Sitework		$ 108,000,000	
	Raw Construction Subtotal	**$ 114,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 28,500,000	
		Construction Cost Subtotal	**$ 142,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 6,400,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 21,400,000	
		Total Construction Cost	**$ 170,300,000**	
	15%	Owner's Reserve for Change Orders	$ 25,500,000	
	15%	Engineering Services (Design)	$ 25,500,000	
	13%	Construction Management	$ 22,100,000	
	12%	Engineering Services During Construction	$ 20,400,000	
		TOTAL CAPITAL COST	**$ 264,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 6,100,000**	
	Traffic Control (Heavy Urban)	7%	48	91,040	LS	$ 67.20	$ 6,100,000	7% of Divisions 2-17
2 - Sitework							**$ 108,000,000**	
	48" Open cut pipeline		48	91,040	LF	$ 960	$ 87,400,000	
	48" Bore and Jack Pipeline & Casing		48	2,550	LF	$ 2,496	$ 6,400,000	
	48" HDD Pipeline		48	-	LF	$ 1,344	$ -	
	48" Microtunnel Pipeline & Casing		48	1,900	LF	$ 3,360	$ 6,400,000	
	Sheeting and Shorting	7%	48	91,040	LF	$ 67.20	$ 6,100,000	
	Potholing (Heavy Urban)	2%	48	91,040	LF	$ 19.20	$ 1,700,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 156,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$163	$ -	
Annual Inspection and Pipeline Maintenance	95,490	LF	$1.63	$ 156,000	
			TOTAL ANNUAL O&M COSTS	**$ 156,000**	

Table 1-15. PS-1, pump station to convey San José AWPF purified water to LGRP (Portfolio 1a)

HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PS-1. Purified water from San José AWPF to LGRP**

Flow **16,667** **gpm**
TDH **400** **feet**
Horsepower **2,877** **hp**

Date: 1/30/2020
Project Number: 437 001 105
Prepared By: I Wald
Checked By: C Lam
Check Date:

Estimate Type: Planning

Cost Summary by Division

Spec. Division	**Subtotal**	**Notes**
1 - General Requirements	$ 1,230,000	
2 - Sitework	$ 1,600,000	
3 - Concrete	$ 1,330,000	
11 - Equipment	$ 1,050,000	
15 - Mechanical	$ 1,000,000	
16 - Electrical	$ 3,300,000	
17 - Instrumentation and Control	$ 2,500,000	
Raw Construction Subtotal	**$ 12,010,000**	

Soft Costs	**Metric**	**Value**	**Cost**	**Notes**
	25%	Construction Contingency	$ 3,000,000	
		Construction Cost Subtotal	**$ 15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 680,000	
	15%	Overhead and Profit	$ 2,250,000	
		Total Construction Cost	**$ 17,940,000**	
	15%	Owner's Reserve for Change Orders	$ 2,690,000	
	15%	Engineering Services (Design)	$ 2,690,000	
	13%	Construction Management	$ 2,330,000	
	12%	Engineering Services During Construction	$ 2,150,000	
		TOTAL CAPITAL COST	**$ 27,800,000**	

Item	**Description**	**Size or Metric**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
1 - General Requirements						**$ 1,230,000**	
	Mobilization/Demobilization	10%	1	LS		$ 1,078,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 150,000	
2 - Sitework						**$ 1,600,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 400,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 250,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Dewatering		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 200,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Access Road		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 300,000	
	Landscaping and Irrigation		1	LS		$ 100,000	
3 - Concrete						**$ 1,330,000**	
	Structural Concrete	18 inch	1	LS		$ 400,000	
	Vaults	12 inch	1	LS		$ 200,000	
	Equipment slabs	12 inch	1	LS		$ 150,000	
	Building slabs	18 inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 200,000	
	CMU Building	25 X 40 foot	1	LS		$ 300,000	
11 - Equipment						**$ 1,050,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 800,000	
	Surge Tank		1	LS		$ 100,000	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost	Total Cost	Notes
	Meters (flow, pressure, power, etc.)			1	LS		$ 150,000	
15 - Mechanical							**$ 1,000,000**	
	Water/Sewer/Storm Utility improvements			1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances			1	LS		$ 800,000	
16 - Electrical							**$ 3,300,000**	
	Electrical Allowance (MCC, wiring, panels)			1	LS		$ 2,500,000	
	Standby generator			1	LS		$ 800,000	
17 - I&C							**$ 2,500,000**	
	I&C/SCADA/Programming Allowance						$ 2,500,000	
ANNUAL O&M COSTS				**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables							**$ 157,000**	
	Equipment			2%		$1,050,000	$ 21,000	2% of Division 11
	Mechanical			2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical			2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation			2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs							**$ 1,516,000**	
	Electricity Requirement	2,877	hp	9,474,391	kWh	$0.16	$ 1,516,000	
						TOTAL ANNUAL O&M COSTS	**$ 1,673,000**	

Table 1-16. LGRP site improvements (Portfolio 1a)

		2019 Estimate (Escalated to $2019)
Divisions		Los Gatos Pond - Baseline Configuration ($2019)
1 - General		$ 595,000
2 - Site Work		$ 4,148,000
3 - Concrete		$ -
5 - Metals		$ -
10 - Specialties		$ -
11 - Equipment		$ -
10 - Specialties		$ -
13 - Special Construction		$ -
14 - Conveying Systems		$ -
15 - Mechanical		$ -
16 - Electrical/Instrumentation		$ 62,000
17 - Instrumentation & Controls		$ 41,000
Subtotal[1]		**$ 4,800,000**
Construction Contingency	15%	$ 724,000
Construction Cost Subtotal		**$ 5,500,000**
Tax on Materials (Applied to half of subtotal)	9%	$ 257,000
Overhead and Profit	15%	$ 832,000
Total Construction Cost		**$ 6,600,000**
Owner's Reserve for Change Orders	15%	$ 1,002,000
Environmental Documentation and Permits	0%	$ -
Engineering Services (Design)	15%	$ 1,002,000
Construction Management	13%	$ 873,000
Engineering Services During Construction	12%	$ 801,000
Total Capital Cost		**$ 11,000,000**
		$ -
O&M Costs		**O&M Costs**
Consumables (Equipment, Mechanical, Electrical, I&C)		$ 10,000
Labor		$ 329,000
Total O&M		**$ 339,000**

1. Subtotal rounded to nearest hundred thousand

RMC
water and environment

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 579,000	
2 - Sitework	$ 4,037,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 40,000	
Subtotal	$ 4,716,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost (2017 $)	Notes
1 - General Requirements							**$ 579,000**	
	Mobilization	10%		1	LS	$413,700	$ 414,000	10% of Divisions 2-17
	Traffic Control	4%		1	LS	$165,480	$ 165,000	Assumed average traffic control was light urban
2 - Sitework							**$ 4,037,000**	
	Page Pond Facilities							
	36", MLCSP, 12' Cover	36	in-dia	1,800	LF	$ 545	$ 980,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 49,000	$ 49,000	9' to 14' of cover
	Potholing			18	EA	$ 6,000	$ 108,000	Heavy Urban, $6,000 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
	Sunnyoaks Facilities							
	18", PVC, 8' Cover	18	in-dia	1,180	LF	$ 334	$ 394,000	100 ft/d production, Full lane AC, bell and spigot installation, 100% import
	Sheeting and Shoring (Open Cut)	3%		1	LS	$ 11,820	$ 12,000	Up to 8' of cover
	Potholing			12	EA	$ 3,600	$ 42,000	Light Urban, $3,600 per 100 feet of pipe

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

30", MLCSP, 12' Cover	30	in-dia	120	LF	$	430	$	52,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	2,600	$	3,000	9' to 14' of cover
Potholing			1	EA	$	6,000	$	7,000	Heavy Urban, $6,000 per 100 feet of pipe
18" BFV	18	in-dia	2	EA	$	8,579	$	17,000	Rs Means
12" Meter	12	in-dia	1	EA	$	15,000	$	15,000	Engineer's estimate
12" FCV	12	in-dia	1	EA	$	25,000	$	25,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	RS Means
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	LS	$	10,000	$	10,000	regrading, etc Engineer's estimate
Budd Ave Facilities									
24", MLCSP, 12' Cover	24	in-dia	1,630	LF	$	477	$	778,000	80 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	5%		1	LS	$	38,900	$	39,000	9' to 14' of cover
Potholing			16	EA	$	3,600	$	59,000	Light Urban, $3,600 per 100 feet of pipe
24" BFV	24	in-dia	2	EA	$	18,055	$	36,000	Rs Means
30" BFV	30	in-dia	2	EA	$	22,000	$	44,000	Engineer's estimate
18" Meter	18	in-dia	1	EA	$	20,000	$	20,000	Engineer's estimate
18" FCV	18	in-dia	1	EA	$	40,000	$	40,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	10,000	$	10,000	regrading, etc Engineer's estimate
Kirk Ditch Facilities									
36", MLCSP, 12' Cover	36	in-dia	40	Allow	$	545	$	22,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	1,100	$	1,000	9' to 14' of cover

RMC
water and environment

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

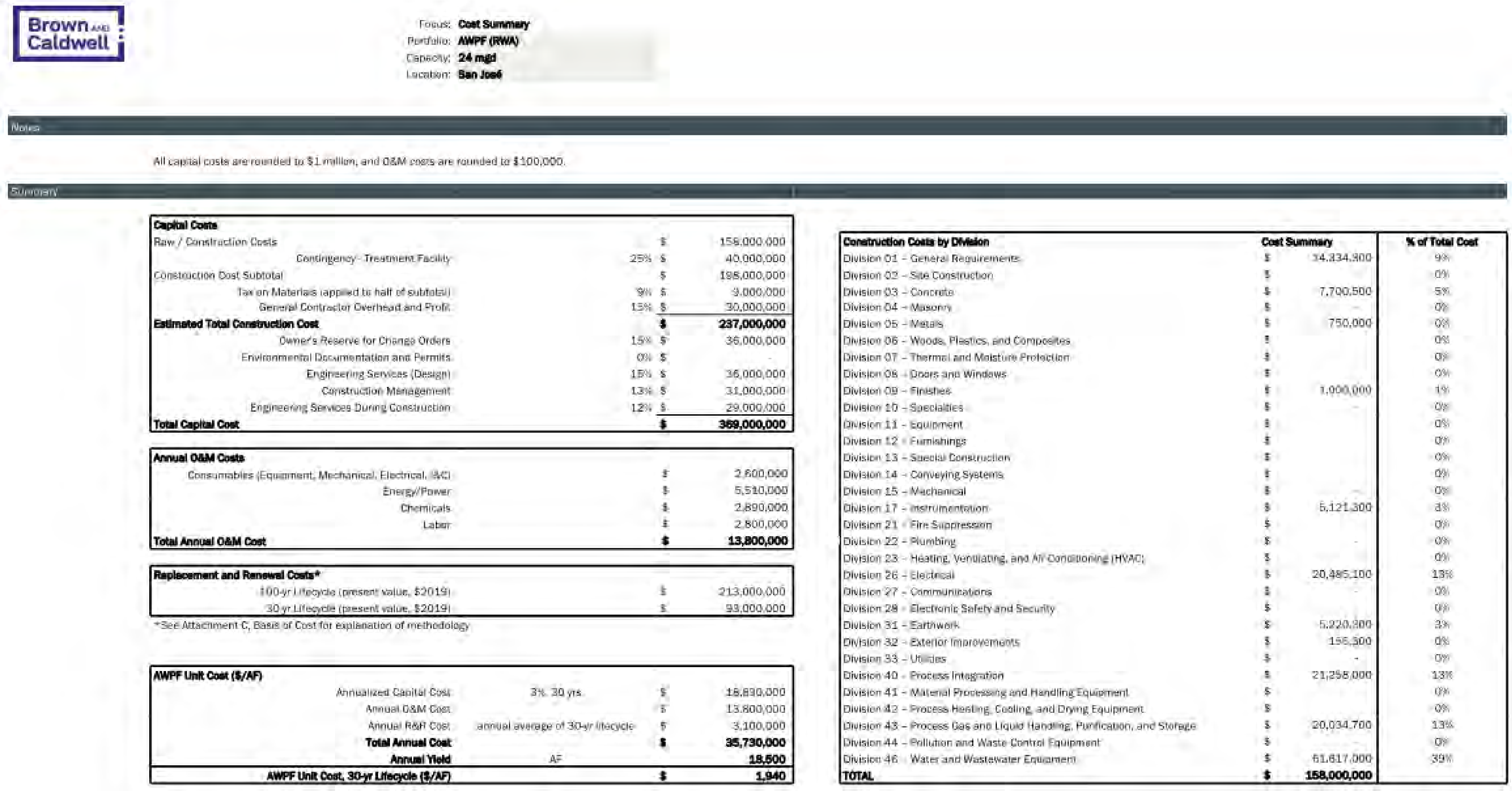
Estimate Type: Planning

Potholing			0	EA	$ 1,200	$ -	Rural, $1,200 per 100 feet of pipe
36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
Vault Box			1	EA	$ 10,116	$ 10,000	
Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
16 - Electrical						**$ 60,000**	
Electrical Allowance			4	EA	$15,000	$ 60,000	Engineers Estimate
17 - I&C						**$ 40,000**	
I&C Allowance			4	EA	$10,000	$ 40,000	Engineers Estimate

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Consumables				**$ 10,000**	
Mechanical	2%		$487,000	$ 10,000	2% of Valves and Meters
Labor Costs				**$ 315,000**	
Pond Maintenance	68	AC	$4,531	$ 307,000	Engineer's estimate
Annual Inspection and Maintenance of Pipeline - Average Annual Operator Hours per Year	47	HR	$175	$ 8,000	Engineer's estimate

Portfolio 1b cost estimate details

Table 1-17. San José AWPF; 24 mgd for RWA (Portfolio 1b)



Focus: **Cost Summary**
Portfolio: **AWPF (RWA)**
Capacity: **24 mgd**
Location: **San José**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	158,000,000
Contingency - Treatment Facility	25%	$	40,000,000
Construction Cost Subtotal		$	198,000,000
Tax on Materials (applied to half of subtotal)	9%	$	9,000,000
General Contractor Overhead and Profit	15%	$	30,000,000
Estimated Total Construction Cost		**$**	**237,000,000**
Owner's Reserve for Change Orders	15%	$	36,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	36,000,000
Construction Management	13%	$	31,000,000
Engineering Services During Construction	12%	$	29,000,000
Total Capital Cost		**$**	**369,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,600,000
Energy/Power	$	5,510,000
Chemicals	$	2,890,000
Labor	$	2,800,000
Total Annual O&M Cost	**$**	**13,800,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	213,000,000
30-yr Lifecycle (present value, $2019)	$	93,000,000

*See Attachment C, Basis of Cost for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	18,830,000
Annual O&M Cost		$	13,800,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	3,100,000
Total Annual Cost		**$**	**35,730,000**
Annual Yield	AF		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,940**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	14,334,900	9%
Division 02 – Site Construction	$		0%
Division 03 – Concrete	$	7,700,500	5%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	750,000	0%
Division 06 – Woods, Plastics, and Composites	$		0%
Division 07 – Thermal and Moisture Protection	$		0%
Division 08 – Doors and Windows	$		0%
Division 09 – Finishes	$	1,000,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$		0%
Division 12 – Furnishings	$		0%
Division 13 – Special Construction	$		0%
Division 14 – Conveying Systems	$		0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	6,121,300	4%
Division 21 – Fire Suppression	$		0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air Conditioning (HVAC)	$		0%
Division 26 – Electrical	$	20,485,100	13%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$		0%
Division 31 – Earthwork	$	5,220,900	3%
Division 32 – Exterior Improvements	$	156,300	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	21,258,000	13%
Division 41 – Material Processing and Handling Equipment	$		0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$		0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	20,034,700	13%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	61,617,000	39%
TOTAL	**$**	**158,000,000**	

Focus: Cost Inputs and R&R
Aspect: AWPF (RWA)
Capacity: 24 mgd
Location: San José

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$143,342,200	10% of Divisions 2-47	$ 14,334,300	
Division 31 – Earthwork	Sitework	Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200	
Division 31 – Earthwork	Sitework	Strip Topsoil		37,534	SY		$ 0.85			$ 32,000	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		19,558	CY		$ 11.78			$ 230,400	
Division 31 – Earthwork	Sitework	Compaction		18,767	CY		$ 0.89			$ 16,800	
Division 31 – Earthwork	Sitework	Grading		37,534	SY		$ 1.18			$ 44,300	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		12,738	CY		$ 58.49			$ 745,100	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		6,500	SY		$ 4.63			$ 30,100	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ 119,500	Ozone and LOX Area
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ 56,800	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactors Slab		213	CY		$ 645		See Site Work and Concrete Tab	$ 137,600	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactor Walls		594	CY		$ 1,090		See Site Work and Concrete Tab	$ 647,300	Ozone and LOX Area
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Suspended Slab		138	CY		$ 1,150		See Site Work and Concrete Tab	$ 159,300	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		291	CY		$ 1,090		See Site Work and Concrete Tab	$ 317,400	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	BAC Filter Slab		373	CY		$ 645		See Site Work and Concrete Tab	$ 240,800	BAC
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ 327,000	BAC
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (RWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 53			$ 155,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco	$ 7,455,900	
Division 46 – Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ 5,741,700	
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	EA	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (RWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 - Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Calcium Chloride Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	40	4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 218.58		245' x 345'; furnished and installed	$ 18,475,300	Process Building
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375.00		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Calcium Chloride Tank (Carbon Steel, Vert.)	10,000	2	EA	$ 120,000			Assumes 30 day storage	$ 240,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 - Process Integration	Mechanical	Piping allowance		30%	% of			$61,617,000	30% of Equipment Costs	$ 18,485,100	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (RWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
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Engineer: R. Guillen
Checked By: D. Mulacek

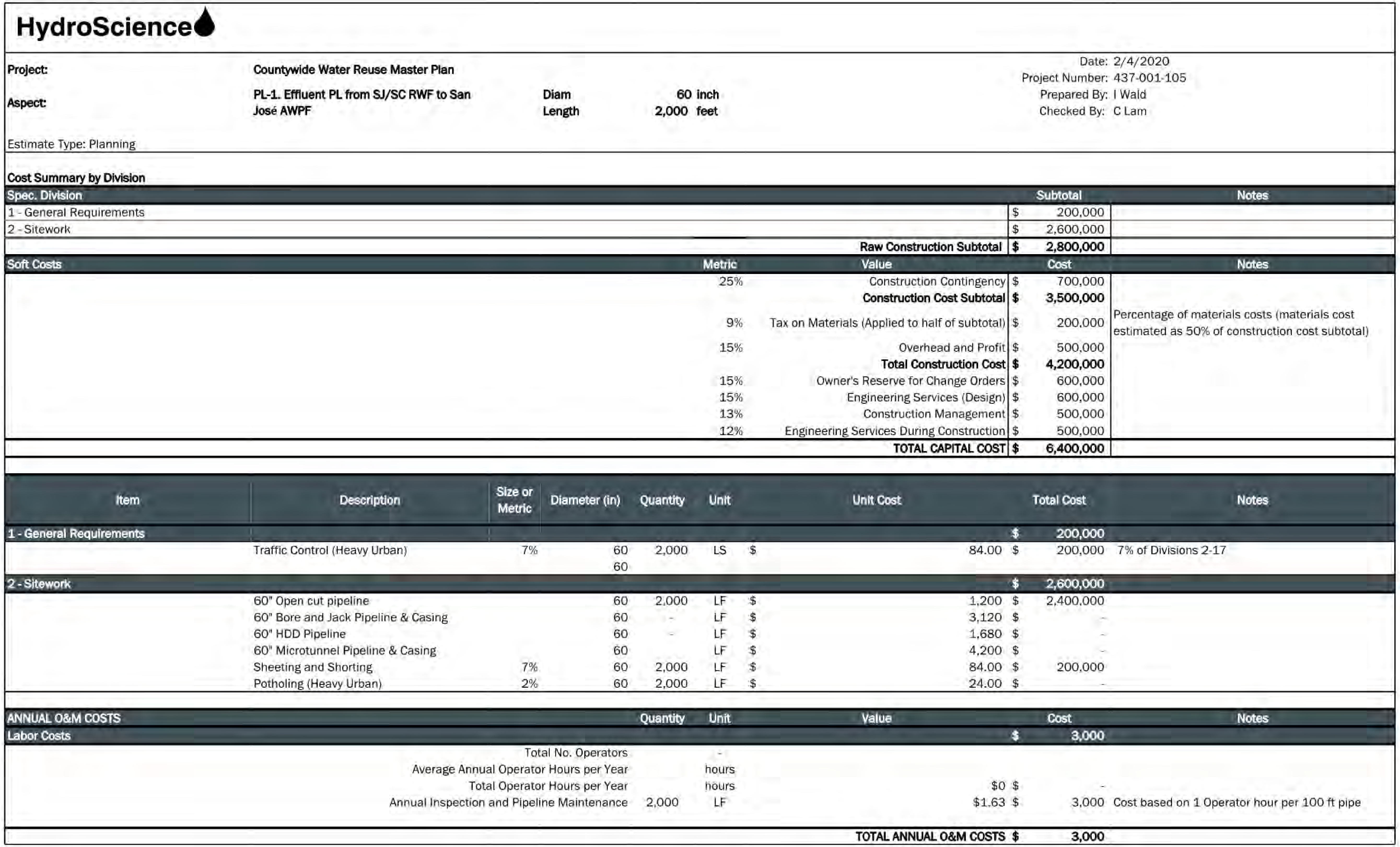
Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$18,485,100	5% of Piping Allowance	$ 924,300	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$18,485,100	5% of Piping Allowance	$ 924,300	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$18,485,100	5% of Piping Allowance	$ 924,300	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$61,617,000	30% of Equipment Costs	$ 18,485,100	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$20,485,100	25% of Electrical Costs	$ 5,121,300	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,750,400	2% of Pumping Equipment Cost	$ 35,100	
O&M	Consumables	Electrical Consumables		2%	% of			$ 20,485,100	2% of Electrical Cost	$ 409,800	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 5,121,300	2% of Instrumentation & Controls Cost	$ 102,500	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,764,439	kWh		$ 0.10			$ 182,600	
O&M	Power	Waste Equalization Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Calcium Chloride		240,000	gal		$ 0.54		Costs based on Expedited Purified Water Program Estimates	$ 130,700	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (RWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Labor	Water Plant Operator		6,240	hours/yr		$ 163.20			$ 1,018,400	Assumes three plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 1-18. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolio 1b)



HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PL-1. Effluent PL from SJ/SC RWF to San José AWPF**

Diam **60 inch**
Length **2,000 feet**

Date: 2/4/2020
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Metric	Value	Subtotal	Notes
1 - General Requirements			$ 200,000	
2 - Sitework			$ 2,600,000	
		Raw Construction Subtotal	**$ 2,800,000**	
Soft Costs	**Metric**	**Value**	**Cost**	**Notes**
	25%	Construction Contingency	$ 700,000	
		Construction Cost Subtotal	**$ 3,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 500,000	
		Total Construction Cost	**$ 4,200,000**	
	15%	Owner's Reserve for Change Orders	$ 600,000	
	15%	Engineering Services (Design)	$ 600,000	
	13%	Construction Management	$ 500,000	
	12%	Engineering Services During Construction	$ 500,000	
		TOTAL CAPITAL COST	**$ 6,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 200,000**	
	Traffic Control (Heavy Urban)	7%	60	2,000	LS	$ 84.00	$ 200,000	7% of Divisions 2-17
			60					
2 - Sitework							**$ 2,600,000**	
	60" Open cut pipeline		60	2,000	LF	$ 1,200	$ 2,400,000	
	60" Bore and Jack Pipeline & Casing		60	-	LF	$ 3,120	$ -	
	60" HDD Pipeline		60	-	LF	$ 1,680	$ -	
	60" Microtunnel Pipeline & Casing		60		LF	$ 4,200	$ -	
	Sheeting and Shorting	7%	60	2,000	LF	$ 84.00	$ 200,000	
	Potholing (Heavy Urban)	2%	60	2,000	LF	$ 24.00	$ -	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 3,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$ -	
Annual Inspection and Pipeline Maintenance	2,000	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 3,000**	

Table 1-19. PL-4, 48-inch purified water pipeline from San José AWPF to Penitencia WTP (Portfolio 1b)

HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PL-4. Purified water PL from San José AWPF to Penitencia WTP**

Diam **48** **inch**
Length **47,100** **feet**

Date: 2/4/2020
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

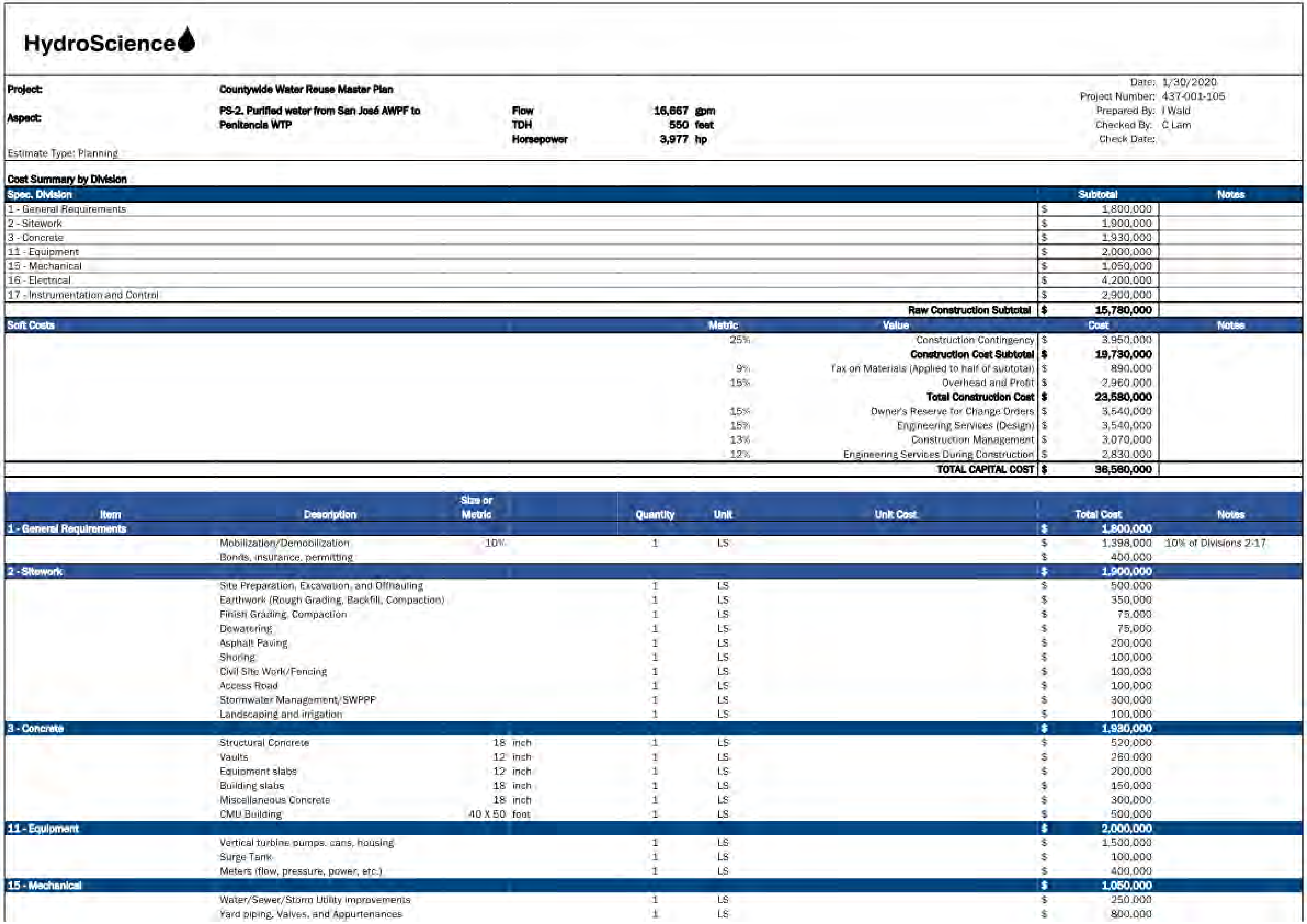
Spec. Division			Subtotal	Notes
1 - General Requirements		$	3,000,000	
2 - Sitework		$	55,300,000	
	Raw Construction Subtotal	**$**	**58,300,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	14,600,000	
		Construction Cost Subtotal	**$**	**72,900,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	3,300,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	10,900,000	
		Total Construction Cost	**$**	**87,100,000**	
	15%	Owner's Reserve for Change Orders	$	13,100,000	
	15%	Engineering Services (Design)	$	13,100,000	
	13%	Construction Management	$	11,300,000	
	12%	Engineering Services During Construction	$	10,500,000	
		TOTAL CAPITAL COST	**$**	**135,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**3,000,000**	
	Traffic Control (Heavy Urban)	7%	48	44,500	LS	$	67.20	$	3,000,000	7% of Divisions 2-17
			48							
2 - Sitework								**$**	**55,300,000**	
	48" Open cut pipeline		48	44,500	LF	$	960	$	42,700,000	
	48" Bore and Jack Pipeline & Casing		48	-	LF	$	2,496	$	-	
	48" HDD Pipeline		48	-	LF	$	1,344	$	-	
	48" Microtunnel Pipeline & Casing		48	2,600	LF	$	3,360	$	8,700,000	
	Sheeting and Shoring	7%	48	44,500	LF	$	67.20	$	3,000,000	
	Potholing (Heavy Urban)	2%	48	44,500	LF	$	19.20	$	900,000	

ANNUAL O&M COSTS		Quantity	Unit	Value		Cost	Notes
Labor Costs					**$**	**77,000**	
	Total No. Operators		-				
	Average Annual Operator Hours per Year		hours				
	Total Operator Hours per Year		hours	$0	$	-	
	Annual Inspection and Pipeline Maintenance	47,100	LF	$1.63	$	77,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$**	**77,000**	

Table 1-20. PS-2, pump station to convey San José AWPF purified water to Penitencia WTP (Portfolio 1b)



HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	1/30/2020
				Project Number:	437-001-105
Aspect:	**PS-2. Purified water from San José AWPF to Penitencia WTP**	**Flow**	**16,667 gpm**	Prepared By:	I Wald
		TDH	**550 feet**	Checked By:	C Lam
		Horsepower	**3,977 hp**	Check Date:	
Estimate Type: Planning					

Cost Summary by Division

Spec. Division		**Subtotal**	**Notes**
1 - General Requirements	$	1,800,000	
2 - Sitework	$	1,900,000	
3 - Concrete	$	1,930,000	
11 - Equipment	$	2,000,000	
15 - Mechanical	$	1,050,000	
16 - Electrical	$	4,200,000	
17 - Instrumentation and Control	$	2,900,000	
Raw Construction Subtotal	**$**	**15,780,000**	

Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	3,950,000	
		Construction Cost Subtotal	**$**	**19,730,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	890,000	
	15%	Overhead and Profit	$	2,960,000	
		Total Construction Cost	**$**	**23,580,000**	
	15%	Owner's Reserve for Change Orders	$	3,540,000	
	15%	Engineering Services (Design)	$	3,540,000	
	13%	Construction Management	$	3,070,000	
	12%	Engineering Services During Construction	$	2,830,000	
		TOTAL CAPITAL COST	**$**	**36,560,000**	

Item	**Description**	**Size or Metric**		**Quantity**	**Unit**	**Unit Cost**		**Total Cost**	**Notes**
1 - General Requirements							**$**	**1,800,000**	
	Mobilization/Demobilization	10%		1	LS		$	1,398,000	10% of Divisions 2-17
	Bonds, insurance, permitting						$	400,000	
2 - Sitework							**$**	**1,900,000**	
	Site Preparation, Excavation, and Offhauling			1	LS		$	500,000	
	Earthwork (Rough Grading, Backfill, Compaction)			1	LS		$	350,000	
	Finish Grading, Compaction			1	LS		$	75,000	
	Dewatering			1	LS		$	75,000	
	Asphalt Paving			1	LS		$	200,000	
	Shoring			1	LS		$	100,000	
	Civil Site Work/Fencing			1	LS		$	100,000	
	Access Road			1	LS		$	100,000	
	Stormwater Management/SWPPP			1	LS		$	300,000	
	Landscaping and irrigation			1	LS		$	100,000	
3 - Concrete							**$**	**1,930,000**	
	Structural Concrete	18	inch	1	LS		$	520,000	
	Vaults	12	inch	1	LS		$	260,000	
	Equipment slabs	12	inch	1	LS		$	200,000	
	Building slabs	18	inch	1	LS		$	150,000	
	Miscellaneous Concrete	18	inch	1	LS		$	300,000	
	CMU Building	40 X 50	foot	1	LS		$	500,000	
11 - Equipment							**$**	**2,000,000**	
	Vertical turbine pumps, cans, housing			1	LS		$	1,500,000	
	Surge Tank			1	LS		$	100,000	
	Meters (flow, pressure, power, etc.)			1	LS		$	400,000	
15 - Mechanical							**$**	**1,050,000**	
	Water/Sewer/Storm Utility improvements			1	LS		$	250,000	
	Yard piping, Valves, and Appurtenances			1	LS		$	800,000	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost	Total Cost	Notes
16 - Electrical							**$ 4,200,000**	
	Electrical Allowance (MCC, wiring, panels)			1	LS		$ 3,000,000	
	Standby generator			1	LS		$ 1,200,000	
17 - I&C							**$ 2,900,000**	
	I&C/SCADA/Programming Allowance						$ 2,900,000	
ANNUAL O&M COSTS				**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables							**$ 203,000**	
	Equipment			2%		$2,000,000	$ 40,000	2% of Division 11
	Mechanical			2%		$1,050,000	$ 21,000	2% of Division 15
	Electrical			2%		$4,200,000	$ 84,000	2% of Division 16
	Instrumentation			2%		$2,900,000	$ 58,000	2% of Division 17
Power Costs							**$ 2,084,000**	
	Electricity Requirement	3,977	hp	13,027,287	kWh	$0.16	$ 2,084,000	
						TOTAL ANNUAL O&M COSTS	**$ 2,287,000**	

Table 1-21. Penitencia WTP site improvements (Portfolio 1b)

RMC
water and environment

Project: SCVWD Purified Water Program
Preliminary Engineering Services

Aspect: Penitencia WTP 3 MG DPR Tank and Pipeline

Date: 26-Sep-17
Project Number: 0027-016.11.3
Prepared By: NH, MM
Checked By: ME
Check Date: 20-Oct-17

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 550,000	
2 - Sitework	$ 5,496,000	
3 - Concrete	$ 55,000	
4 - Masonry	$ -	
5 - Metals	$ 50,000	
6 - Wood and Plastic	$ -	
7 - Moisture and Thermal Protection	$ -	
8 - Doors and Windows	$ -	
9 - Finishes	$ -	
10 - Specialties	$ -	
11 - Equipment	$ 76,000	
12 - Furnishings	$ -	
13 - Special Construction	$ 15,495,000	
14 - Conveying Systems	$ -	
15 - Mechanical	$ 1,169,000	
16 - Electrical	$ 93,000	
17 - Instrumentation and Control	$ 43,000	
Subtotal	$ 23,027,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 550,000**	
	Mobilization	10%		1	LS	$549,600	$ 550,000	10% of Divisions 2-17
2 - Sitework							**$ 5,496,000**	
	Site Clear and Grub			4	Acre	$9,156	$ 35,000	
	Strip Topsoil			18,457	SY	$0.77	$ 15,000	
	Compaction			166,110	SF	$1.14	$ 190,000	
	Grading			6,152	CY	$1.52	$ 10,000	
	Excavation			31,779	CY	$15	$ 487,000	
	Offhaul Allowance			31,779	CY	$12	$ 385,000	
	Aggregate Base			1,667	CY	$59	$ 99,000	
	Asphalt			10,000	SF	$3	$ 27,000	
	Chain Linke Fence Arround Penitencia WTP			2,946	LF	$67	$ 199,000	
	Lighting and Security Allowance			1	LS	$20,000	$ 20,000	
	Conveyance Pipelines							
	66-inch blended DPR Water, MLCSP, 8' Cover	66	in-dia	1,800	LF	$958	$ 1,726,000	
	Sheeting and Shoring (Open Cut)	3%		1	LS	$51,780	$ 52,000	
	Potholing			18	EA	$1,200	$ 22,000	
	66-inch Blended and Penitencia Force Main (Central Pipeline) Connection			1	LS	$100,000	$ 100,000	

48-inch DPR Pipeline, MLCSP, 8' Cover to 3 MG Tank	48	in-dia	2,108	LF	$632	$	1,333,000	
Sheeting and Shoring (Open Cut)	3%		1	LS	$39,990	$	40,000	
Potholing			21	EA	$1,200	$	25,000	
48-inch DPR Pipeline, MLCSP, 8' Cover to 3 MG Tank	48	in-dia	566	LF	$632	$	358,000	Rs Means
Sheeting and Shoring (Open Cut)	3%		1	LS	$10,740	$	11,000	Engineer's estimate
Potholing			6	EA	$1,200	$	7,000	Vendor estimate
36-inch DPR Bypass Pipeline, MLCSP, 8' Cover	42	in-dia	520	LF	$464	$	242,000	RS Means
Sheeting and Shoring (Open Cut)	3%		1	LS	$7,260	$	7,000	RS Means
Potholing			5	EA	$1,200	$	6,000	RS Means
36-inch DPR Bypass Pipeline and 42-inch existing bypass connection			1	LS	$100,000	$	100,000	
3 - Concrete						**$**	**55,000**	
Chemical Storage								
Chemial Storage Slab			56	CY	$800	$	44,000	
Chemical Storage Area Walls			11	CY	$1,000	$	11,000	
5 - Metals						**$**	**50,000**	
Misc. Metals Allowance			1	LS	$50,000	$	50,000	
11 - Equipment						**$**	**76,000**	
Chemical Dosing								
Sodium Bisulfite Metering Pumps			2	EA	$38,000	$	76,000	Skid mounted pump; incl. valves and appurtenances
13 - Special Construction						**$**	**15,495,498**	
3 MG storage tank								
Purified Water Storage Tank			1	LS	$5,391,000	$	5,400,000	
Foundation Stabilization			1	EA	$10,000,000	$	10,000,000	
66" Fitting on Existing Tank			1	EA	$50,000	$	50,000	
Chemical Storage Canopy								
Chemical Storage Area Canopy			325	SF	$97	$	31,498	
Chemical Tanks								
Sodium Bisulfite Tank (HDXLPE, Vert.)	3000	gallons	2	EA	$7,000	$	14,000	
15 - Mechanical						**$**	**1,169,050**	
Piping Allowance	10%		1	LS	$9,000	$	9,000	
Valve Allowance	10%		1	LS	$9,000	$	9,000	
Pipe Supports for supporting daylighted 66" blended pipeline before connection with the PFM			2	EA	$150,000	$	300,000	
66" BFV	66		1	EA	$60,000	$	60,000	
36" FCV	36		1	EA	$113,050	$	113,050	
48" BFV	48		3	EA	$25,979	$	78,000	
Flow Control Valve Vault	48		1	EA	$100,000	$	100,000	
Magnetic Flow Meter and Vault	48		1	EA	$200,000	$	200,000	
Magnetic Flow Meter and Vault	66		1	EA	$300,000	$	300,000	
16 - Electrical						**$**	**93,000**	
Electrical Allowance for 3 MG Tank			1	LS	$20,000	$	20,000	
Electrical Allowance for Chemical Storage	30%		1	LS	$23,000	$	23,000	
Feeder Electrical Line to Tank			1	LS	$50,000	$	50,000	
17 - I&C						**$**	**43,000**	
I&C Allowance for the 3 MG Tank			1	EA	$20,000	$	20,000	
I&C Allowance for Chemical Storage	30%		1	LS	$23,000	$	23,000	

Portfolios 1c and 1d cost estimate details

Table 1-22. San José AWPF; 24 mgd for TWA (Portfolios 1c and 1d)

Brown AND Caldwell

Focus: **Cost Summary**
Portfolio: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **San José**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	167,000,000
Contingency - Treatment Facility	25%	$	42,000,000
Construction Cost Subtotal		$	209,000,000
Tax on Materials (applied to half of subtotal)	9%	$	10,000,000
General Contractor Overhead and Profit	15%	$	32,000,000
Estimated Total Construction Cost		**$**	**251,000,000**
Owner's Reserve for Change Orders	15%	$	38,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	38,000,000
Construction Management	13%	$	33,000,000
Engineering Services During Construction	12%	$	31,000,000
Total Capital Cost		**$**	**391,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	3,650,000
Energy/Power	$	5,890,000
Chemicals	$	2,910,000
Labor	$	3,850,000
Total Annual O&M Cost	**$**	**16,300,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	216,000,000
30-yr Lifecycle (present value, $2019)	$	94,000,000

*See Attachment C. Basis of Cost for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	19,950,000
Annual O&M Cost		$	16,300,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	3,133,333
Total Annual Cost		**$**	**39,383,333**
Annual Yield	AF		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**2,130**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	15,183,600	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	8,514,900	5%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	750,000	0%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	1,000,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	5,121,300	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	20,485,100	12%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	5,250,300	3%
Division 32 – Exterior Improvements	$	155,300	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	21,258,000	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	27,683,800	17%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	61,617,000	37%
TOTAL	**$**	**167,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$151,835,700	10% of Divisions 2-47	$ 15,183,600	
Division 31 – Earthwork	Sitework	Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200	
Division 31 – Earthwork	Sitework	Strip Topsoil		37,534	SY		$ 0.85			$ 32,000	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		22,423	CY		$ 11.78			$ 264,200	
Division 31 – Earthwork	Sitework	Compaction		18,767	CY		$ 0.89			$ 16,800	
Division 31 – Earthwork	Sitework	Grading		37,534	SY		$ 1.18			$ 44,300	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		12,738	CY		$ 58.49			$ 745,100	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		5,666	SY		$ 4.63			$ 26,300	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ 119,500	Ozone and LOX Area
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ 56,800	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactors Slab		320	CY		$ 645		See Site Work and Concrete Tab	$ 206,400	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactor Walls		576	CY		$ 1,090		See Site Work and Concrete Tab	$ 627,900	Ozone and LOX Area
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Suspended Slab		138	CY		$ 1,150		See Site Work and Concrete Tab	$ 159,300	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		291	CY		$ 1,090		See Site Work and Concrete Tab	$ 317,400	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	BAC Filter Slab		427	CY		$ 645		See Site Work and Concrete Tab	$ 275,200	BAC
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ 327,000	BAC
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Slab		538	CY		$ 645		See Site Work and Concrete Tab	$ 346,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Walls, including interior channel Walls		233	CY		$ 1,090		See Site Work and Concrete Tab	$ 253,600	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Suspended Slab		202	CY		$ 645		See Site Work and Concrete Tab	$ 130,100	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 53			$ 155,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 - Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco. Costs includes ozone generators, LOX system, injection skids, reaction systems, destruct units, cooling systems, Nitrogen boost skid, ozone control panel, and pumps.	$ 7,455,900	
Division 46 - Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ 5,741,700	
Division 46 - Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	EA	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 - Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 - Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 - Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Lime Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	40	4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 218.58		245' x 345'; furnished and installed	$ 18,475,300	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375.00		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	2	EA	$ 3,650,000			From DN Tanks cost proposal, need two 4 MG tanks	$ 7,300,000	Prestressed Concrete Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Storage Silos	17,500	2	EA	$ 183,750				$ 367,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Slurry Batching Tank	2,000	2	EA	$ 5,793				$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Slurry Storage Tank	10,000	2	EA	$ 105,000				$ 210,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$61,617,000	30% of Equipment Costs	$ 18,485,100	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$18,485,100	5% of Piping Allowance	$ 924,300	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$18,485,100	5% of Piping Allowance	$ 924,300	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$18,485,100	5% of Piping Allowance	$ 924,300	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$61,617,000	30% of Equipment Costs	$ 18,485,100	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$20,485,100	25% of Electrical Costs	$ 5,121,300	
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$ 1,046,200	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,675,400	2% of Pumping Equipment Cost	$ 33,600	
O&M	Consumables	Electrical Consumables		2%	% of			$ 20,485,100	2% of Electrical Cost	$ 409,800	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 5,121,300	2% of Instrumentation & Controls Cost	$ 102,500	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ 290,800	
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ 14,900	
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ 21,800	
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ 30,500	
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ 11,900	
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ 4,000	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	

Brown AND Caldwell

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **San José**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,764,439	kWh		$ 0.10			$ 182,600	
O&M	Power	Waste Equalization Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ 21,100	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Lime		877,226	lb		$ 0.15		based on 12 mg/L dose	$ 131,500	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		8,320	hours/yr		$ 163.20			$ 1,357,900	Assumes three plant operators 40 hours per week for 52 weeks in a year (4 FTE)
O&M	Labor	Sr Mechanics		6,240	hours/yr		$ 172.27			$ 1,075,000	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Control Tech II		6,240	hours/yr		$ 172.27			$ 1,075,000	Assumes two control tech 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 1-23. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolios 1c and 1d)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	2/4/2020
				Project Number:	437-001-105
Aspect:	**PL-1. Effluent PL from SJ/SC RWF to San José AWPF**	**Diam**	**60 inch**	Prepared By:	I Wald
		Length	**2,000 feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 200,000	
2 - Sitework	$ 2,600,000	
Raw Construction Subtotal	**$ 2,800,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 700,000	
		Construction Cost Subtotal	**$ 3,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 500,000	
		Total Construction Cost	**$ 4,200,000**	
	15%	Owner's Reserve for Change Orders	$ 600,000	
	15%	Engineering Services (Design)	$ 600,000	
	13%	Construction Management	$ 500,000	
	12%	Engineering Services During Construction	$ 500,000	
		TOTAL CAPITAL COST	**$ 6,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 200,000**	
	Traffic Control (Heavy Urban)	7%	60	2,000	LS	$ 84.00	$ 200,000	7% of Divisions 2-17
			60					
2 - Sitework							**$ 2,600,000**	
	60" Open cut pipeline		60	2,000	LF	$ 1,200	$ 2,400,000	
	60" Bore and Jack Pipeline & Casing		60	-	LF	$ 3,120	$ -	
	60" HDD Pipeline		60	-	LF	$ 1,680	$ -	
	60" Microtunnel Pipeline & Casing		60		LF	$ 4,200	$ -	
	Sheeting and Shorting	7%	60	2,000	LF	$ 84.00	$ 200,000	
	Potholing (Heavy Urban)	2%	60	2,000	LF	$ 24.00	$ -	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 3,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$ -	
Annual Inspection and Pipeline Maintenance	2,000	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 3,000**	

Table 1-24. PL-40, 36-inch purified water pipeline from San José AWPF to Gibraltar Reservoir at the Milpitas Pipeline North Terminus (Portfolio 1c)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/13/2020
				Project Number:	437-001-105
Aspect:	**PL-40: SJ AWPF to Gibraltar (TWA)**	Diam	36 inch	Prepared By:	C Lam
		Length	20,800 feet	Checked By:	C Lam
				Check Date:	

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Metric	Value		Subtotal	Notes
1 - General Requirements			$	1,000,000	
2 - Sitework			$	16,800,000	
		Raw Construction Subtotal	$	**18,000,000**	
Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	4,500,000	
		Construction Cost Subtotal	$	**22,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,000,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	3,400,000	
		Total Construction Cost	$	**26,900,000**	
	15%	Owner's Reserve for Change Orders	$	4,000,000	
	15%	Engineering Services (Design)	$	4,000,000	
	13%	Construction Management	$	3,500,000	
	12%	Engineering Services During Construction	$	3,200,000	
		Total Capital Cost	$	**42,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								$	**1,000,000**	
	Traffic Control (Heavy Urban)	7%	36	20,800	LS	$	50.40	$	1,000,000	7% of Divisions 2-17
			36							
2 - Sitework								$	**16,800,000**	
	36" Open cut pipeline		36	18,800	LF	$	720	$	13,500,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$	1,872	$	-	
	36" HDD Pipeline		36	2,000	LF	$	1,008	$	2,000,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$	2,520	$	-	
	Sheeting and Shorting	7%	36	20,800	LF	$	50.40	$	1,000,000	
	Potholing (Heavy Urban)	2%	36	18,800	LF	$	14.40	$	300,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				$	**34,000**	
Annual Inspection and Pipeline Maintenance	20,800	LF	$1.63	$	34,000	
			TOTAL ANNUAL O&M COSTS	$	**34,000**	

Table 1-25. PL-41, 24-inch purified water pipeline from San José AWPF to delivery point North of Hwy 101 in Santa Clara (Portfolio 1c)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/13/2020
				Project Number:	437-001-105
Aspect:	**PL-41: SJ AWPF to SJ Muni and Santa Clara (N of Hwy 101) (TWA)**	**Diam**	**24 inch**	Prepared By:	C Lam
		Length	**24,700 feet**	Checked By:	C Lam
				Check Date:	

Estimate Type: Planning

Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 800,000	
2 - Sitework			$ 13,300,000	
		Raw Construction Subtotal	**$ 14,000,000**	
Soft Costs	**Metric**	**Value**	**Cost**	**Notes**
	25%	Construction Contingency	$ 3,500,000	
		Construction Cost Subtotal	**$ 17,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,600,000	
		Total Construction Cost	**$ 20,900,000**	
	15%	Owner's Reserve for Change Orders	$ 3,100,000	
	15%	Engineering Services (Design)	$ 3,100,000	
	13%	Construction Management	$ 2,700,000	
	12%	Engineering Services During Construction	$ 2,500,000	
		Total Capital Cost	**$ 32,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 800,000**	
	Traffic Control (Heavy Urban)	7%	24	24,700	LS	$ 33.60	$ 800,000	7% of Divisions 2-17
			24					
2 - Sitework							**$ 13,300,000**	
	24" Open cut pipeline		24	23,550	LF	$ 480	$ 11,300,000	
	24" Bore and Jack Pipeline & Casing		24	300	LF	$ 1,248	$ 400,000	
	24" HDD Pipeline		24	850	LF	$ 672	$ 600,000	
	24" Microtunnel Pipeline & Casing		24	-	LF	$ 1,680	$ -	
	Sheeting and Shoring	7%	24	24,700	LF	$ 33.60	$ 800,000	
	Potholing (Heavy Urban)	2%	24	23,550	LF	$ 9.60	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 40,000**	
Annual Inspection and Pipeline Maintenance	24,700	LF	51.63	$ 40,000	
			TOTAL ANNUAL O&M COSTS	**$ 40,000**	

Table 1-26. PS-14, pump station to convey San José AWPF purified water to Penitenica WTP modulating valve vault via PL-40 and Milpitas Pipeline (Portfolios 1c)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/13/2020
				Project Number:	437-001-105
Aspect:	**PS-14. Purified water from San José AWPF to PWTP mod valve through MPL (TWA)**	**Flow**	**16,667 gpm**	Prepared By:	C Lam
		TDH	**350 feet**	Checked By:	C Lam
		Horsepower	**2,500 hp**	Check Date:	

Estimate Type: Planning

Cost Summary by Division

Spec. Division		**Subtotal**	**Notes**
1 - General Requirements	$	1,670,000	
2 - Sitework	$	1,900,000	
3 - Concrete	$	1,930,000	
11 - Equipment	$	2,000,000	
15 - Mechanical	$	1,050,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**14,350,000**	

Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	3,590,000	
		Construction Cost Subtotal	**$**	**17,940,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	810,000	
	15%	Overhead and Profit	$	2,690,000	
		Total Construction Cost	**$**	**21,440,000**	
	15%	Owner's Reserve for Change Orders	$	3,220,000	
	15%	Engineering Services (Design)	$	3,220,000	
	13%	Construction Management	$	2,790,000	
	12%	Engineering Services During Construction	$	2,570,000	
		TOTAL CAPITAL COST	**$**	**33,240,000**	

Item	**Description**	**Size or Metric**	**Quantity**	**Unit**	**Unit Cost**		**Total Cost**	**Notes**
1 - General Requirements						**$**	**1,670,000**	
	Mobilization/Demobilization	10%	1	LS		$	1,268,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	400,000	
2 - Sitework						**$**	**1,900,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	500,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	350,000	
	Finish Grading, Compaction		1	LS		$	75,000	
	Dewatering		1	LS		$	75,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	100,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	100,000	
3 - Concrete						**$**	**1,930,000**	
	Structural Concrete	18 inch	1	LS		$	520,000	
	Vaults	12 inch	1	LS		$	260,000	
	Equipment slabs	12 inch	1	LS		$	200,000	
	Building slabs	18 inch	1	LS		$	150,000	
	Miscellaneous Concrete	18 inch	1	LS		$	300,000	
	CMU Building	40 X 50 foot	1	LS		$	500,000	
11 - Equipment						**$**	**2,000,000**	
	Vertical turbine pumps, cans, housing		1	LS		$	1,500,000	
	Surge Tank		1	LS		$	100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	400,000	
15 - Mechanical						**$**	**1,050,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
	Water/Sewer/Storm Utility improvements		1	LS		$ 250,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						**$ 3,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						**$ 2,500,000**	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 177,000**	
	Equipment		2%		$2,000,000	$ 40,000	2% of Division 11
	Mechanical		2%		$1,050,000	$ 21,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						**$ 1,742,000**	
	Electricity Requirement	2,500 hp	10,887,397	kWh	$0.16	$ 1,742,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,919,000**	

Table 1-27. PS-15, pump station to convey San José AWPF purified water to delivery point North of Hwy 101 in Santa Clara (Portfolios 1c)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/13/2020
				Project Number:	437-001-105
Aspect:	**PS-15. Purified water from San José AWPF to Santa Clara (N of Hwy 101) (TWA)**	**Flow**	**8,333 gpm**	Prepared By:	C Lam
		TDH	**250 feet**	Checked By:	C Lam
		Horsepower	**890 hp**	Check Date:	
Estimate Type: Planning					

Cost Summary by Division

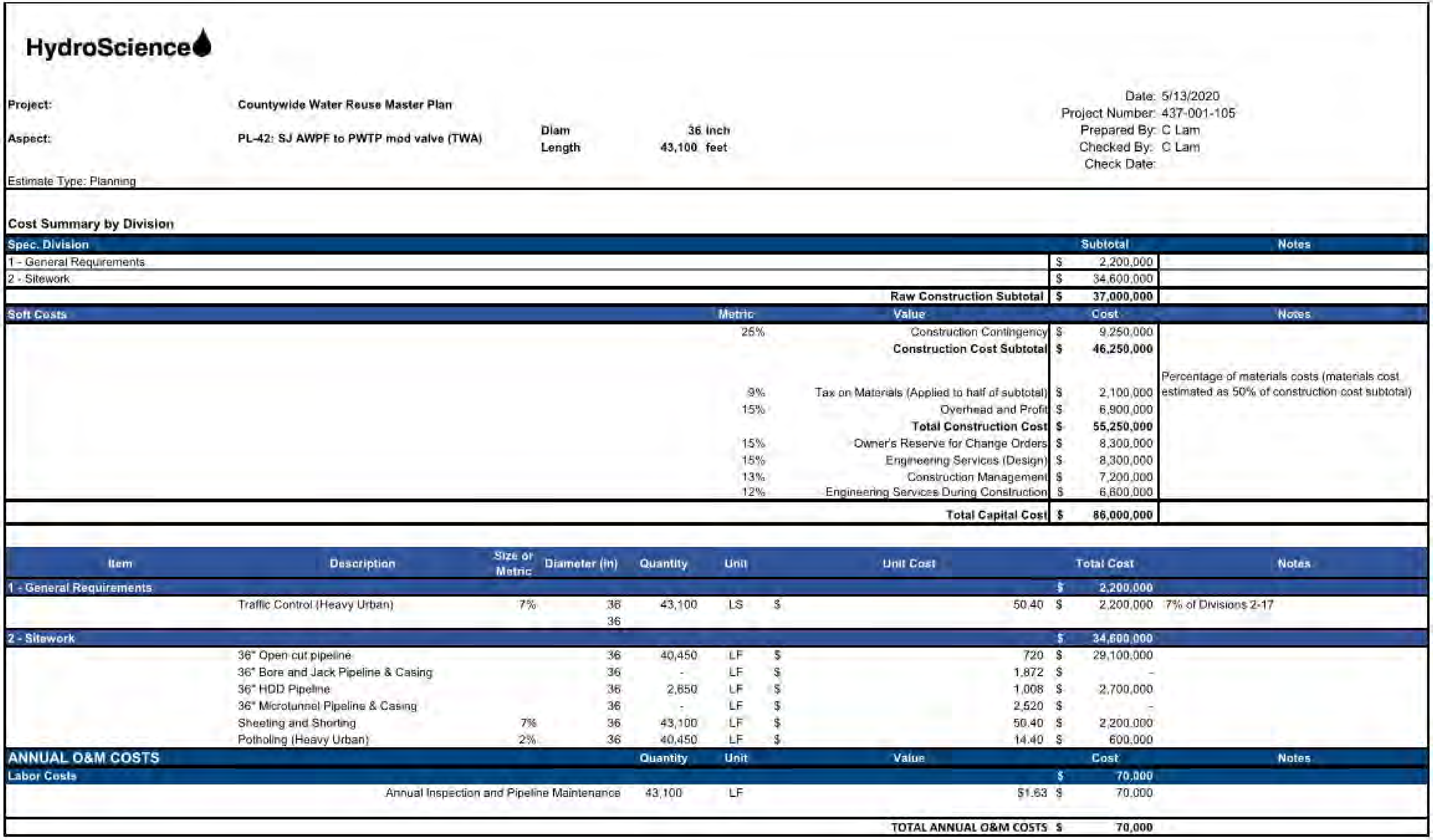
Spec. Division		Subtotal	Notes
1 - General Requirements	$	750,000	
2 - Sitework	$	1,050,000	
3 - Concrete	$	780,000	
11 - Equipment	$	650,000	
15 - Mechanical	$	540,000	
16 - Electrical	$	1,750,000	
17 - Instrumentation and Control	$	1,250,000	
Raw Construction Subtotal	**$**	**6,770,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	1,690,000	
		Construction Cost Subtotal	**$**	**8,460,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	380,000	
	15%	Overhead and Profit	$	1,270,000	
		Total Construction Cost	**$**	**10,110,000**	
	15%	Owner's Reserve for Change Orders	$	1,520,000	
	15%	Engineering Services (Design)	$	1,520,000	
	13%	Construction Management	$	1,310,000	
	12%	Engineering Services During Construction	$	1,210,000	
		TOTAL CAPITAL COST	**$**	**15,670,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**750,000**	
	Mobilization/Demobilization	10%	1	LS		$	602,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,050,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	250,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	200,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS				
	Stormwater Management/SWPPP		1	LS		$	100,000	
	Landscaping and irrigation		1	LS		$	50,000	
3 - Concrete						**$**	**780,000**	
	Structural Concrete	18 inch	1	LS		$	300,000	
	Vaults	12 inch	1	LS		$	100,000	
	Equipment slabs	12 inch	1	LS		$	50,000	
	Building slabs	18 inch	1	LS		$	50,000	
	Miscellaneous Concrete	18 inch	1	LS		$	75,000	
	CMU Building	40 X 50 foot	1	LS		$	200,000	
11 - Equipment						**$**	**650,000**	
	Vertical turbine pumps, cans, housing		1	LS		$	450,000	
	Surge Tank		1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	125,000	
15 - Mechanical						**$**	**540,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
	Water/Sewer/Storm Utility improvements		1	LS		$ 140,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 400,000	
16 - Electrical						**$ 1,750,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,250,000	
	Standby generator		1	LS		$ 500,000	
17 - I&C						**$ 1,250,000**	
	I&C/SCADA/Programming Allowance					$ 1,250,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 83,800**	
	Equipment		2%		$650,000	$ 13,000	2% of Division 11
	Mechanical		2%		$540,000	$ 10,800	2% of Division 15
	Electrical		2%		$1,750,000	$ 35,000	2% of Division 16
	Instrumentation		2%		$1,250,000	$ 25,000	2% of Division 17
Power Costs						**$ 620,000**	
	Electricity Requirement	890 hp	3,877,278	kWh	$0.16	$ 620,000	
					TOTAL ANNUAL O&M COSTS	**$ 703,800**	

Table 1-28. PL-42, 36-inch purified water pipeline from San José AWPF to modulating valve vault at Penitencia WTP (Portfolio 1d)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-42: SJ AWPF to PWTP mod valve (TWA)

Diam 36 inch
Length 43,100 feet

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	2,200,000	
2 - Sitework	$	34,600,000	
Raw Construction Subtotal	$	**37,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	9,250,000	
		Construction Cost Subtotal	$	**46,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	2,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	6,900,000	
		Total Construction Cost	$	**55,250,000**	
	15%	Owner's Reserve for Change Orders	$	8,300,000	
	15%	Engineering Services (Design)	$	8,300,000	
	13%	Construction Management	$	7,200,000	
	12%	Engineering Services During Construction	$	6,800,000	
		Total Capital Cost	$	**86,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								$	2,200,000	
	Traffic Control (Heavy Urban)	7%	36	43,100	LS	$	50.40	$	2,200,000	7% of Divisions 2-17
			36							
2 - Sitework								$	34,600,000	
	36" Open cut pipeline		36	40,450	LF	$	720	$	29,100,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$	1,872	$	-	
	36" HDD Pipeline		36	2,650	LF	$	1,008	$	2,700,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$	2,520	$	-	
	Sheeting and Shoring	7%	36	43,100	LF	$	50.40	$	2,200,000	
	Potholing (Heavy Urban)	2%	36	40,450	LF	$	14.40	$	600,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				$	70,000	
Annual Inspection and Pipeline Maintenance	43,100	LF	$1.63	$	70,000	
TOTAL ANNUAL O&M COSTS				$	70,000	

Table 1-29. PL-43, 24-inch purified water pipeline from San José AWPF to delivery point North of Hwy 101 in Santa Clara (Portfolios 1d)

HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PL-43: SJ AWPF to SJ Muni and Santa Clara (N of Hwy 101) (TWA)**

Diam **24 inch**
Length **24,700 feet**

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Metric	Value		Subtotal	Notes
1 - General Requirements			$	800,000	
2 - Sitework			$	13,300,000	
		Raw Construction Subtotal	**$**	**14,000,000**	
Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	3,500,000	
		Construction Cost Subtotal	**$**	**17,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	2,600,000	
		Total Construction Cost	**$**	**20,900,000**	
	15%	Owner's Reserve for Change Orders	$	3,100,000	
	15%	Engineering Services (Design)	$	3,100,000	
	13%	Construction Management	$	2,700,000	
	12%	Engineering Services During Construction	$	2,500,000	
		Total Capital Cost	**$**	**32,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**800,000**	
	Traffic Control (Heavy Urban)	7%	24	24,700	LS	$	33.60	$	800,000	7% of Divisions 2-17
			24							
2 - Sitework								**$**	**13,300,000**	
	24" Open cut pipeline		24	23,550	LF	$	480	$	11,300,000	
	24" Bore and Jack Pipeline & Casing		24	300	LF	$	1,248	$	400,000	
	24" HDD Pipeline		24	850	LF	$	672	$	600,000	
	24" Microtunnel Pipeline & Casing		24	-	LF	$	1,680	$	-	
	Sheeting and Shorting	7%	24	24,700	LF	$	33.60	$	800,000	
	Potholing (Heavy Urban)	2%	24	23,550	LF	$	9.60	$	200,000	

ANNUAL O&M COSTS	**Quantity**	**Unit**	**Value**		**Cost**	**Notes**
Labor Costs				**$**	**40,000**	
Annual Inspection and Pipeline Maintenance	24,700	LF	$1.63	$	40,000	
			TOTAL ANNUAL O&M COSTS	**$**	**40,000**	

Table 1-30. PS-16, pump station to convey San José AWPF purified water to Penitenica WTP modulating valve vault via PL-42 (Portfolio 1d)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 5/13/2020 Project Number: 437-001-105
Aspect:	**PS-16. Purified water from San José AWPF to PWTP mod valve through new PL (TWA)**	**Flow** **TDH** **Horsepower**	**16,667 gpm** **350 feet** **2,500 hp**	Prepared By: C Lam Checked By: C Lam Check Date:
Estimate Type: Planning				

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 1,670,000	
2 - Sitework	$ 1,900,000	
3 - Concrete	$ 1,930,000	
11 - Equipment	$ 2,000,000	
15 - Mechanical	$ 1,050,000	
16 - Electrical	$ 3,300,000	
17 - Instrumentation and Control	$ 2,500,000	
Raw Construction Subtotal	**$ 14,350,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,590,000	
		Construction Cost Subtotal	**$ 17,940,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 810,000	
	15%	Overhead and Profit	$ 2,690,000	
		Total Construction Cost	**$ 21,440,000**	
	15%	Owner's Reserve for Change Orders	$ 3,220,000	
	15%	Engineering Services (Design)	$ 3,220,000	
	13%	Construction Management	$ 2,790,000	
	12%	Engineering Services During Construction	$ 2,570,000	
		TOTAL CAPITAL COST	**$ 33,240,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 1,670,000**	
	Mobilization/Demobilization	10%	1	LS		$ 1,268,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 400,000	
2 - Sitework						**$ 1,900,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 500,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 350,000	
	Finish Grading, Compaction		1	LS		$ 75,000	
	Dewatering		1	LS		$ 75,000	
	Asphalt Paving		1	LS		$ 200,000	
	Shoring		1	LS		$ 100,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Access Road		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 300,000	
	Landscaping and irrigation		1	LS		$ 100,000	
3 - Concrete						**$ 1,930,000**	
	Structural Concrete	18 inch	1	LS		$ 520,000	
	Vaults	12 inch	1	LS		$ 260,000	
	Equipment slabs	12 inch	1	LS		$ 200,000	
	Building slabs	18 inch	1	LS		$ 150,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 300,000	
	CMU Building	40 X 50 foot	1	LS		$ 500,000	
11 - Equipment						**$ 2,000,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 1,500,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 400,000	
15 - Mechanical						**$ 1,050,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
	Water/Sewer/Storm Utility improvements		1	LS		$ 250,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						**$ 3,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						**$ 2,500,000**	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 177,000**	
	Equipment		2%		$2,000,000	$ 40,000	2% of Division 11
	Mechanical		2%		$1,050,000	$ 21,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						**$ 1,742,000**	
	Electricity Requirement	2,500 hp	10,887,397	kWh	$0.16	$ 1,742,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,919,000**	

Table 1-31. PS-17, pump station to convey San José AWPF purified water to delivery point North of Hwy 101 in Santa Clara (Portfolio 1d)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 5/13/2020
				Project Number: 437-001-105
Aspect:	**PS-17. Purified water from San José AWPF to Santa Clara (N of Hwy 101) (TWA)**	**Flow**	**8,333 gpm**	Prepared By: C Lam
		TDH	**250 feet**	Checked By: C Lam
		Horsepower	**890 hp**	Check Date:
Estimate Type: Planning				

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	750,000	
2 - Sitework	$	1,050,000	
3 - Concrete	$	780,000	
11 - Equipment	$	650,000	
15 - Mechanical	$	540,000	
16 - Electrical	$	1,750,000	
17 - Instrumentation and Control	$	1,250,000	
Raw Construction Subtotal	**$**	**6,770,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	1,690,000	
		Construction Cost Subtotal	**$**	**8,460,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	380,000	
	15%	Overhead and Profit	$	1,270,000	
		Total Construction Cost	**$**	**10,110,000**	
	15%	Owner's Reserve for Change Orders	$	1,520,000	
	15%	Engineering Services (Design)	$	1,520,000	
	13%	Construction Management	$	1,310,000	
	12%	Engineering Services During Construction	$	1,210,000	
		TOTAL CAPITAL COST	**$**	**15,670,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**750,000**	
	Mobilization/Demobilization	10%	1	LS		$	602,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,050,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	250,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	200,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS				
	Stormwater Management/SWPPP		1	LS		$	100,000	
	Landscaping and irrigation		1	LS		$	50,000	
3 - Concrete						**$**	**780,000**	
	Structural Concrete	18 inch	1	LS		$	300,000	
	Vaults	12 inch	1	LS		$	100,000	
	Equipment slabs	12 inch	1	LS		$	50,000	
	Building slabs	18 inch	1	LS		$	50,000	
	Miscellaneous Concrete	18 inch	1	LS		$	75,000	
	CMU Building	40 X 50 foot	1	LS		$	200,000	
11 - Equipment						**$**	**650,000**	
	Vertical turbine pumps, cans, housing		1	LS		$	450,000	
	Surge Tank		1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	125,000	
15 - Mechanical						**$**	**540,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
	Water/Sewer/Storm Utility improvements		1	LS		$ 140,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 400,000	
16 - Electrical						**$ 1,750,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,250,000	
	Standby generator		1	LS		$ 500,000	
17 - I&C						**$ 1,250,000**	
	I&C/SCADA/Programming Allowance					$ 1,250,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 83,800**	
	Equipment		2%		$650,000	$ 13,000	2% of Division 11
	Mechanical		2%		$540,000	$ 10,800	2% of Division 15
	Electrical		2%		$1,750,000	$ 35,000	2% of Division 16
	Instrumentation		2%		$1,250,000	$ 25,000	2% of Division 17
Power Costs						**$ 620,000**	
	Electricity Requirement	890 hp	3,877,278	kWh	$0.16	$ 620,000	
					TOTAL ANNUAL O&M COSTS	**$ 703,800**	

Portfolio 2a cost estimate details

Table 1-32. Combined Regional AWPF in Palo Alto; 24 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 2a)

Focus: **Cost Summary**
Element: **AWPF (GWR)**
Capacity / Treatment: **24.5 mgd**
Location: **Palo Alto**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	124,000,000
Contingency - Treatment Facility	25%	$	31,000,000
Construction Cost Subtotal		$	155,000,000
Tax on Materials (applied to half of subtotal)	9%	$	7,000,000
General Contractor Overhead and Profit	15%	$	24,000,000
Estimated Total Construction Cost		**$**	**186,000,000**
Owner's Reserve for Change Orders	15%	$	28,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	28,000,000
Construction Management	13%	$	25,000,000
Engineering Services During Construction	12%	$	23,000,000
Total Capital Cost		**$**	**290,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,490,000
Energy/Power	$	5,390,000
Chemicals	$	2,890,000
Labor	$	2,800,000
Total Annual O&M Cost	**$**	**13,570,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	166,000,000
30-yr Lifecycle (present value, $2019)	$	73,000,000

*See Attachment C, Basis of Cost for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	14,800,000
Annual O&M Cost		$	13,570,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	2,430,000
Total Annual Cost		**$**	**30,800,000**
Annual Yield	AF		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,670**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	11,291,400	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	7,131,400	$ 0
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	750,000	1%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	1,000,000	1%
Division 10 – Specialties	$	-	0%
	$	-	0%
Division 11 – Equipment			
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	4,097,300	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	16,389,200	13%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	4,040,800	3%
Division 32 – Exterior Improvements	$	111,200	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	16,547,700	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	14,881,800	12%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	47,964,000	39%
TOTAL	**$**	**124,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **24.5 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$ 112,913,400	10% of Divisions 2-47	$ 11,291,400	
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500	
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		37,566	CY		$ 11.78			$ 442,600	
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000	
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		11,261	CY		$ 58.49			$ 658,700	
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500	
Division 31 – Earthwork	Sitework	Gravel		12,781	SY		$ 4.63			$ 59,200	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineers estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		1,200	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 449,400	Unit cost was obtained interpolating available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 449,400	9' to 14' of cover	$ 22,500	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		4,515	CY		$ 645		See Site Work and Concrete Tab	$ 2,912,200	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **24.5 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 53			$ 111,200	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Calcium Chloride Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements

Focus:	**Cost Inputs and R&R**	Date:	2/5/2020
Aspect:	**AWPF (GWR)**	BC Project Number:	151772
Capacity:	**24.5 mgd**	Estimate Version Number:	2.0
Location:	**Palo Alto**	Estimate Date:	R. Guillen
		Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		60,950	SF		$ 219		265' x 230'; furnished and installed	$ 13,322,400	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Calcium Chloride Tank (Carbon Steel, Vert.)	10,000	2	EA	$ 120,000			Assumes 30 day storage	$ 240,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 47,964,000	30% of Equipment Costs	$ 14,389,200	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 47,964,000	30% of Equipment Costs	$ 14,389,200	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 16,389,200	25% of Electrical Costs	$ 4,097,300	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **24.5 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
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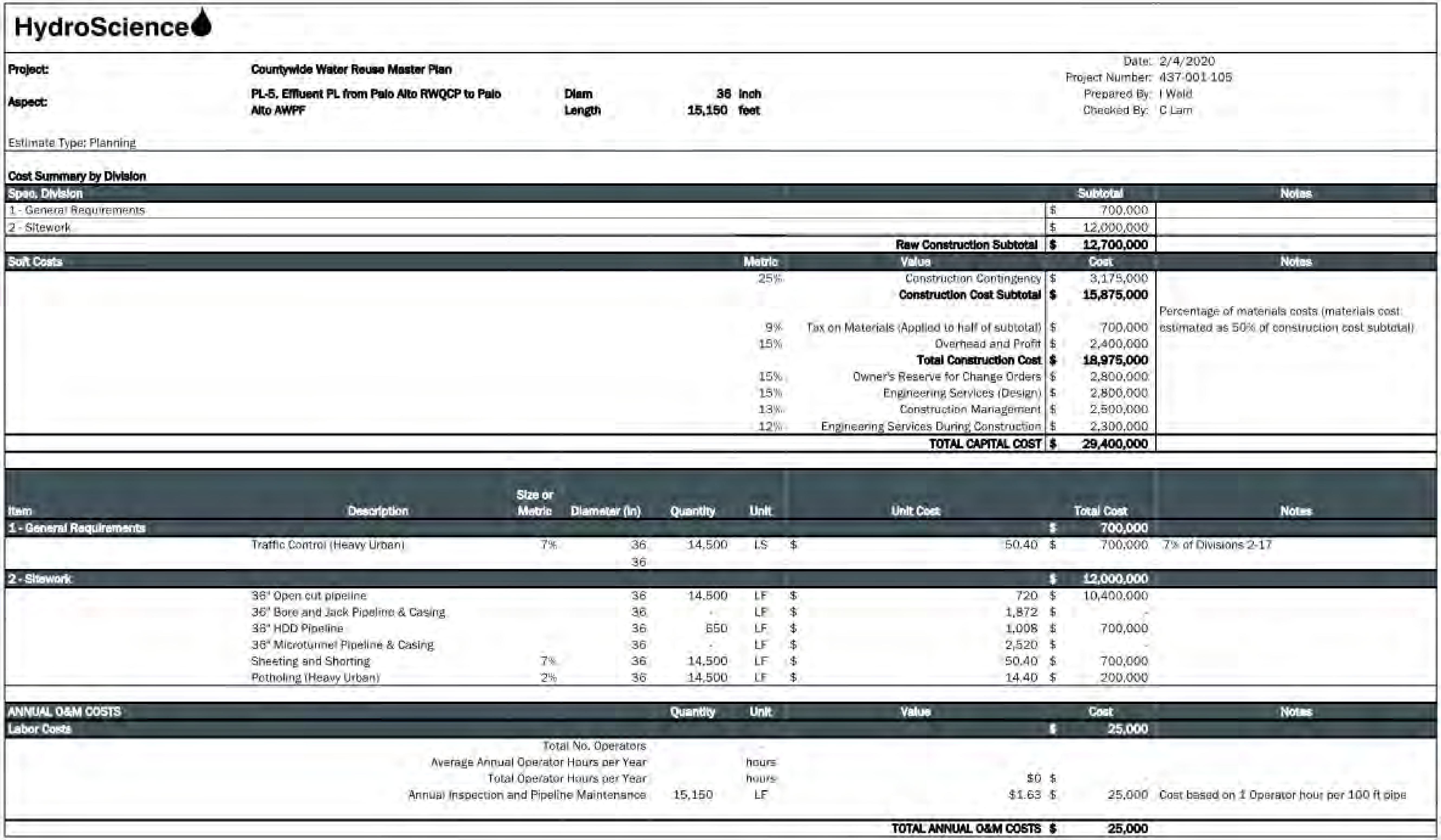
Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,295,000	2% of Pumping Equipment Cost	$ 25,900	
O&M	Consumables	Electrical Consumables		2%	% of			$ 16,389,200	2% of Electrical Cost	$ 327,800	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 4,097,300	2% of Instrumentation & Controls Cost	$ 82,000	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,176,293	kWh		$ 0.10			$ 121,700	
O&M	Power	Waste Equalization Pumps		196,049	kWh		$ 0.10			$ 20,300	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Calcium Chloride		240,000	gal		$ 0.54		Costs based on Expedited Purified Water Program Estimates	$ 130,700	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		6,240	hours/yr		$ 163.20			$ 1,018,400	Assumes three plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 1-33. PL-5, 36-inch effluent pipeline from Palo Alto RWQCP to Palo Alto AWPF (Portfolio 2a)



HydroScience

Project:	**Countywide Water Reuse Master Plan**				Date:	2/4/2020
					Project Number:	437-001-105
Aspect:	**PL-5. Effluent PL from Palo Alto RWQCP to Palo Alto AWPF**	**Diam**	**36**	**inch**	Prepared By:	I Wold
		Length	**15,150**	**feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements		$	700,000	
2 - Sitework		$	12,000,000	
	Raw Construction Subtotal	**$**	**12,700,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,175,000	
		Construction Cost Subtotal	**$**	**15,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	2,400,000	
		Total Construction Cost	**$**	**18,975,000**	
	15%	Owner's Reserve for Change Orders	$	2,800,000	
	15%	Engineering Services (Design)	$	2,800,000	
	13%	Construction Management	$	2,500,000	
	12%	Engineering Services During Construction	$	2,300,000	
		TOTAL CAPITAL COST	**$**	**29,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**700,000**	
	Traffic Control (Heavy Urban)	7%	36	14,500	LS	$	50.40	$	700,000	7% of Divisions 2-17
			36							
2 - Sitework								**$**	**12,000,000**	
	36" Open cut pipeline		36	14,500	LF	$	720	$	10,400,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$	1,872	$	-	
	36" HDD Pipeline		36	650	LF	$	1,008	$	700,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$	2,520	$	-	
	Sheeting and Shorting	7%	36	14,500	LF	$	50.40	$	700,000	
	Potholing (Heavy Urban)	2%	36	14,500	LF	$	14.40	$	200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**25,000**	
Total No. Operators		-				
Average Annual Operator Hours per Year		hours				
Total Operator Hours per Year		hours	$0	$	-	
Annual Inspection and Pipeline Maintenance	15,150	LF	$1.63	$	25,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**25,000**	

Table 1-34. PL-6, 36-inch effluent pipeline from Sunnyvale WPCP to Palo Alto AWPF (Portfolio 2a)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	2/4/2020
				Project Number:	437-001-105
Aspect:	**PL-6. Effluent PL from Sunnyvale WPCP to Palo Alto AWPF**	**Diam**	**36 inch**	Prepared By:	I Wald
		Length	**38,820 feet**	Checked By:	C Lam

Estimate Type: Planning

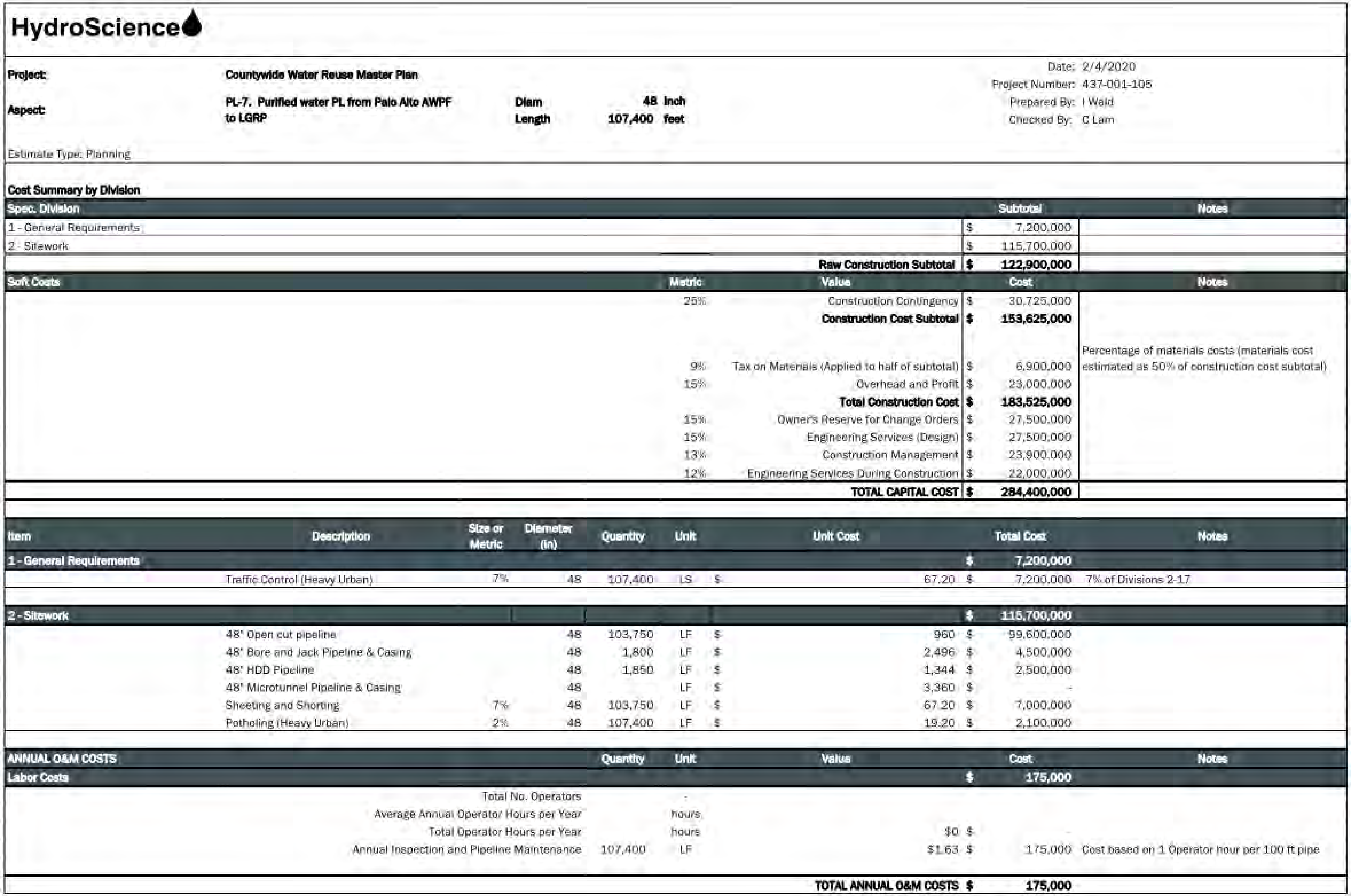
Cost Summary by Division

Spec. Division				**Subtotal**	**Notes**
1 - General Requirements			$	1,900,000	
2 - Sitework			$	30,100,000	
		Raw Construction Subtotal	**$**	**32,000,000**	
Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	8,000,000	
		Construction Cost Subtotal	**$**	**40,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	6,000,000	
		Total Construction Cost	**$**	**47,800,000**	
	15%	Owner's Reserve for Change Orders	$	7,200,000	
	15%	Engineering Services (Design)	$	7,200,000	
	13%	Construction Management	$	6,200,000	
	12%	Engineering Services During Construction	$	5,700,000	
		TOTAL CAPITAL COST	**$**	**74,100,000**	

Item	**Description**	**Size or Metric**	**Diameter (in)**	**Quantity**	**Unit**	**Unit Cost**		**Total Cost**	**Notes**
1 - General Requirements							**$**	**1,900,000**	
	Traffic Control (Heavy Urban)	7%	36	38,320	LS	$ 50.40	$	1,900,000	7% of Divisions 2-17
			36						
2 - Sitework							**$**	**30,100,000**	
	36" Open cut pipeline		36	38,320	LF	$ 720	$	27,600,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$ 1,872	$	-	
	36" HDD Pipeline		36	-	LF	$ 1,008	$	-	
	36" Microtunnel Pipeline & Casing		36	-	LF	$ 2,520	$	-	
	Sheeting and Shoring	7%	36	38,320	LF	$ 50.40	$	1,900,000	
	Potholing (Heavy Urban)	2%	36	38,320	LF	$ 14.40	$	600,000	

ANNUAL O&M COSTS	**Quantity**	**Unit**	**Value**		**Cost**	**Notes**
Labor Costs				**$**	**63,000**	
Total No. Operators		-				
Average Annual Operator Hours per Year		hours				
Total Operator Hours per Year		hours	$0	$	-	
Annual Inspection and Pipeline Maintenance	38,820	LF	$1.63	$	63,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**63,000**	

Table 1-35. PL-7, 48-inch purified water pipeline from Palo Alto AWPF to LGRP (Portfolio 2a)



HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 2/4/2020 Project Number: 437-001-105
Aspect:	**PL-7. Purified water PL from Palo Alto AWPF to LGRP**	**Diam** **Length**	**48 inch** **107,400 feet**	Prepared By: I Wald Checked By: C Lam

Estimate Type: Planning

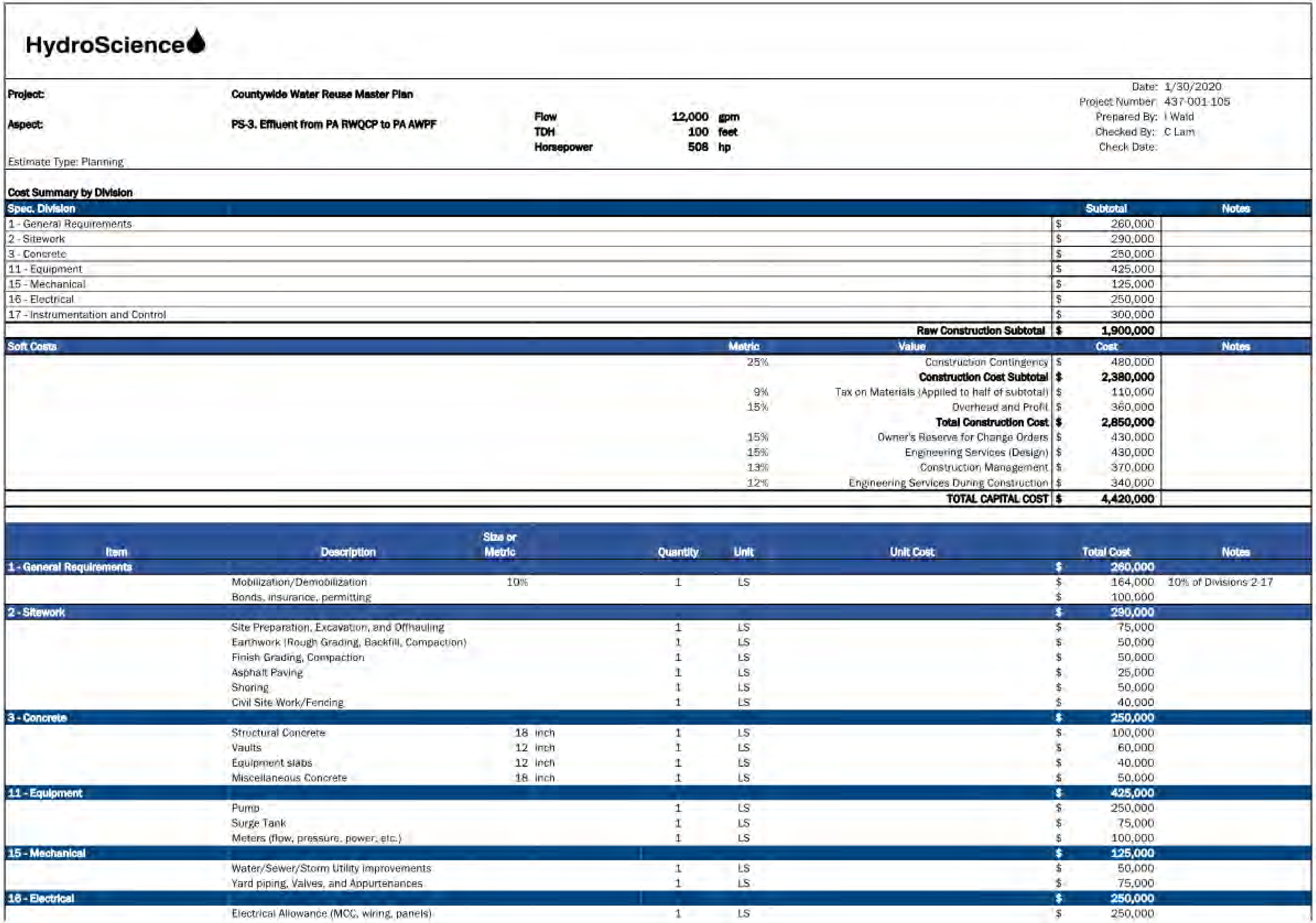
Cost Summary by Division

Spec. Division				Subtotal	Notes
1 - General Requirements			$	7,200,000	
2 - Sitework			$	115,700,000	
		Raw Construction Subtotal	**$**	**122,900,000**	
Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	30,725,000	
		Construction Cost Subtotal	**$**	**153,625,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	6,900,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	23,000,000	
		Total Construction Cost	**$**	**183,525,000**	
	15%	Owner's Reserve for Change Orders	$	27,500,000	
	15%	Engineering Services (Design)	$	27,500,000	
	13%	Construction Management	$	23,900,000	
	12%	Engineering Services During Construction	$	22,000,000	
		TOTAL CAPITAL COST	**$**	**284,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**7,200,000**	
	Traffic Control (Heavy Urban)	7%	48	107,400	LS	$	67.20	$	7,200,000	7% of Divisions 2-17
2 - Sitework								**$**	**115,700,000**	
	48" Open cut pipeline		48	103,750	LF	$	960	$	99,600,000	
	48" Bore and Jack Pipeline & Casing		48	1,800	LF	$	2,496	$	4,500,000	
	48" HDD Pipeline		48	1,850	LF	$	1,344	$	2,500,000	
	48" Microtunnel Pipeline & Casing		48		LF	$	3,360	$	-	
	Sheeting and Shorting	7%	48	103,750	LF	$	67.20	$	7,000,000	
	Potholing (Heavy Urban)	2%	48	107,400	LF	$	19.20	$	2,100,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**175,000**	
Total No. Operators		-				
Average Annual Operator Hours per Year		hours				
Total Operator Hours per Year		hours	$0	$	-	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$	175,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**175,000**	

Table 1-36. PS-3, pump station to convey Palo Alto RWQCP effluent to Palo Alto AWPF (Portfolio 2a)



HydroScience

Project: **Countywide Water Reuse Master Plan**
Aspect: **PS-3. Effluent from PA RWQCP to PA AWPF**
Estimate Type: Planning

Flow	**12,000**	**gpm**
TDH	**100**	**feet**
Horsepower	**508**	**hp**

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		**Subtotal**	**Notes**
1 - General Requirements	$	260,000	
2 - Sitework	$	290,000	
3 - Concrete	$	250,000	
11 - Equipment	$	425,000	
15 - Mechanical	$	125,000	
16 - Electrical	$	250,000	
17 - Instrumentation and Control	$	300,000	
Raw Construction Subtotal	**$**	**1,900,000**	

Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	480,000	
		Construction Cost Subtotal	**$**	**2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	110,000	
	15%	Overhead and Profit	$	360,000	
		Total Construction Cost	**$**	**2,850,000**	
	15%	Owner's Reserve for Change Orders	$	430,000	
	15%	Engineering Services (Design)	$	430,000	
	13%	Construction Management	$	370,000	
	12%	Engineering Services During Construction	$	340,000	
		TOTAL CAPITAL COST	**$**	**4,420,000**	

Item	**Description**	**Size or Metric**	**Quantity**	**Unit**	**Unit Cost**		**Total Cost**	**Notes**
1 - General Requirements						**$**	**260,000**	
	Mobilization/Demobilization	10%	1	LS		$	164,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	100,000	
2 - Sitework						**$**	**290,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	25,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	40,000	
3 - Concrete						**$**	**250,000**	
	Structural Concrete	18 inch	1	LS		$	100,000	
	Vaults	12 inch	1	LS		$	60,000	
	Equipment slabs	12 inch	1	LS		$	40,000	
	Miscellaneous Concrete	18 inch	1	LS		$	50,000	
11 - Equipment						**$**	**425,000**	
	Pump		1	LS		$	250,000	
	Surge Tank		1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	100,000	
15 - Mechanical						**$**	**125,000**	
	Water/Sewer/Storm Utility Improvements		1	LS		$	50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$	75,000	
16 - Electrical						**$**	**250,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$	250,000	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost	Total Cost	Notes
17 - I&C							**$ 300,000**	
	I&C/SCADA/Programming Allowance						$ 300,000	
ANNUAL O&M COSTS				**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables							**$ 22,000**	
	Equipment			2%		$425,000	$ 8,500	2% of Division 11
	Mechanical			2%		$125,000	$ 2,500	2% of Division 15
	Electrical			2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation			2%		$300,000	$ 6,000	2% of Division 17
Power Costs							**$ 332,000**	
	Electricity Requirement	508	hp	1,749,177	kWh	$0.19	$ 332,000	
						TOTAL ANNUAL O&M COSTS	**$ 354,000**	

Table 1-37. PS-4, pump station to convey Sunnyvale WPCP effluent to Palo Alto AWPF (Portfolio 2a)

HydroScience

Project:	**Countywide Water Reuse Master Plan**				Date:	1/30/2020
Aspect:	**PS-4. Effluent from Sunnyvale WPCP to Palo Alto AWPF**	**Flow**	**8,000**	**gpm**	Project Number:	437-001-105
		TDH	**100**	**feet**	Prepared By:	I Wald
		Horsepower	**400**	**hp**	Checked By:	C Lam
					Check Date:	
Estimate Type: Planning						

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	260,000	
2 - Sitework	$	290,000	
3 - Concrete	$	250,000	
11 - Equipment	$	425,000	
15 - Mechanical	$	125,000	
16 - Electrical	$	250,000	
17 - Instrumentation and Control	$	300,000	
Raw Construction Subtotal	**$**	**1,900,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	480,000	
		Construction Cost Subtotal	**$**	**2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	110,000	
	15%	Overhead and Profit	$	360,000	
		Total Construction Cost	**$**	**2,850,000**	
	15%	Owner's Reserve for Change Orders	$	430,000	
	15%	Engineering Services (Design)	$	430,000	
	13%	Construction Management	$	370,000	
	12%	Engineering Services During Construction	$	340,000	
		TOTAL CAPITAL COST	**$**	**4,420,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**260,000**	
	Mobilization/Demobilization	10%	1	LS		$	164,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	100,000	
2 - Sitework						**$**	**290,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	25,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	40,000	
	Access Road		1	LS		$	-	on plant site
	Stormwater Management/SWPPP		1	LS		$	-	on plant site
3 - Concrete						**$**	**250,000**	
	Structural Concrete	18 inch	1	LS		$	100,000	
	Vaults	12 inch	1	LS		$	60,000	
	Equipment slabs	12 inch	1	LS		$	40,000	
	Miscellaneous Concrete	18 inch	1	LS		$	50,000	
11 - Equipment						**$**	**425,000**	
	Pump		1	LS		$	250,000	
	Surge Tank		1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	100,000	
15 - Mechanical						**$**	**125,000**	
	Water/Sewer/Storm Utility Improvements		1	LS		$	50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$	75,000	
16 - Electrical						**$**	**250,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 250,000	
17 - I&C						**$ 300,000**	
	I&C/SCADA/Programming Allowance					$ 300,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 22,000**	
	Equipment		2%		$425,000	$ 8,500	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$300,000	$ 6,000	2% of Division 17
Power Costs						**$ 479,000**	
	Electricity Requirement	400 hp	2,996,340	kWh	$0.16	$ 479,000	
					TOTAL ANNUAL O&M COSTS	**$ 501,000**	

Table 1-38. PS-5, pump station to convey Palo Alto AWPF purified water to LGRP (Portfolio 2a)

HydroScience

Project: **Countywide Water Reuse Master Plan**
Aspect: **PS-5. Purified water from PA AWPF to LGRP**
Estimate Type: Planning

Flow	**16,667**	**gpm**
TDH	**400**	**feet**
Horsepower	**2,877**	**hp**

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam
Check Date:

Cost Summary by Division

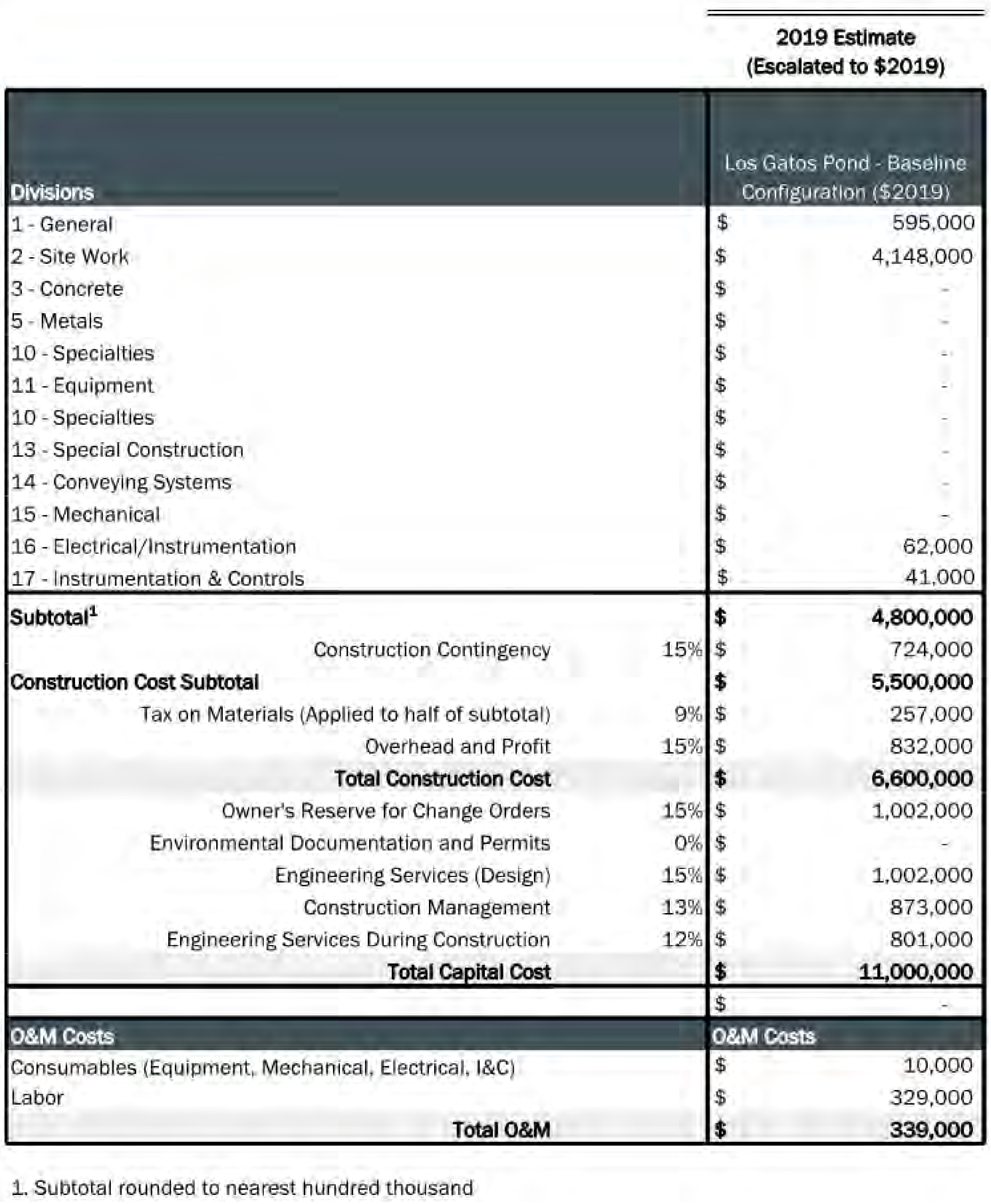
Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,230,000	
2 - Sitework	$	1,600,000	
3 - Concrete	$	1,330,000	
11 - Equipment	$	1,050,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,010,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,000,000	
		Construction Cost Subtotal	**$**	**15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	680,000	
	15%	Overhead and Profit	$	2,250,000	
		Total Construction Cost	**$**	**17,940,000**	
	15%	Owner's Reserve for Change Orders	$	2,690,000	
	15%	Engineering Services (Design)	$	2,690,000	
	13%	Construction Management	$	2,330,000	
	12%	Engineering Services During Construction	$	2,150,000	
		TOTAL CAPITAL COST	**$**	**27,800,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**1,230,000**	
	Mobilization/Demobilization	10%	1	LS		$	1,078,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,600,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	250,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	100,000	
3 - Concrete						**$**	**1,330,000**	
	Structural Concrete	18 inch	1	LS		$	400,000	
	Vaults	12 inch	1	LS		$	200,000	
	Equipment slabs	12 inch	1	LS		$	150,000	
	Building slabs	18 inch	1	LS		$	75,000	
	Miscellaneous Concrete	18 inch	1	LS		$	200,000	
	CMU Building	25 X 40 foot	1	LS		$	300,000	
11 - Equipment						**$**	**1,050,000**	
	Vertical turbine pumps, cans, housing		1	LS		$	800,000	
	Surge Tank		1	LS		$	100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	150,000	
15 - Mechanical						**$**	**1,000,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$	200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$	800,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
16 - Electrical						**$ 3,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						**$ 2,500,000**	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 157,000**	
	Equipment		2%		$1,050,000	$ 21,000	2% of Division 11
	Mechanical		2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						**$ 1,800,000**	
	Electricity Requirement	2,877 hp	9,474,391	kWh	$0.19	$ 1,800,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,957,000**	

Table 1-39. LGRP site improvements (Portfolio 2a)



Divisions		2019 Estimate (Escalated to $2019) Los Gatos Pond - Baseline Configuration ($2019)
1 - General		$ 595,000
2 - Site Work		$ 4,148,000
3 - Concrete		$ -
5 - Metals		$ -
10 - Specialties		$ -
11 - Equipment		$ -
10 - Specialties		$ -
13 - Special Construction		$ -
14 - Conveying Systems		$ -
15 - Mechanical		$ -
16 - Electrical/Instrumentation		$ 62,000
17 - Instrumentation & Controls		$ 41,000
Subtotal[1]		**$ 4,800,000**
Construction Contingency	15%	$ 724,000
Construction Cost Subtotal		**$ 5,500,000**
Tax on Materials (Applied to half of subtotal)	9%	$ 257,000
Overhead and Profit	15%	$ 832,000
Total Construction Cost		**$ 6,600,000**
Owner's Reserve for Change Orders	15%	$ 1,002,000
Environmental Documentation and Permits	0%	$ -
Engineering Services (Design)	15%	$ 1,002,000
Construction Management	13%	$ 873,000
Engineering Services During Construction	12%	$ 801,000
Total Capital Cost		**$ 11,000,000**
		$ -
O&M Costs		**O&M Costs**
Consumables (Equipment, Mechanical, Electrical, I&C)		$ 10,000
Labor		$ 329,000
Total O&M		**$ 339,000**

1. Subtotal rounded to nearest hundred thousand

RMC
water and environment

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 579,000	
2 - Sitework	$ 4,037,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 40,000	
Subtotal	$ 4,716,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost (2017 $)	Notes
1 - General Requirements							**$ 579,000**	
	Mobilization	10%		1	LS	$413,700	$ 414,000	10% of Divisions 2-17
	Traffic Control	4%		1	LS	$165,480	$ 165,000	Assumed average traffic control was light urban
2 - Sitework							**$ 4,037,000**	
	Page Pond Facilities							
	36", MLCSP, 12' Cover	36	in-dia	1,800	LF	$ 545	$ 980,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 49,000	$ 49,000	9' to 14' of cover
	Potholing			18	EA	$ 6,000	$ 108,000	Heavy Urban, $6,000 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
	Sunnyoaks Facilities							
	18", PVC, 8' Cover	18	in-dia	1,180	LF	$ 334	$ 394,000	100 ft/d production, Full lane AC, bell and spigot installation, 100% import
	Sheeting and Shoring (Open Cut)	3%		1	LS	$ 11,820	$ 12,000	Up to 8' of cover
	Potholing			12	EA	$ 3,600	$ 42,000	Light Urban, $3,600 per 100 feet of pipe

RMC water and environment

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

30", MLCSP, 12' Cover	30	in-dia	120	LF	$	430	$	52,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	2,600	$	3,000	9' to 14' of cover
Potholing			1	EA	$	6,000	$	7,000	Heavy Urban, $6,000 per 100 feet of pipe
18" BFV	18	in-dia	2	EA	$	8,579	$	17,000	Rs Means
12" Meter	12	in-dia	1	EA	$	15,000	$	15,000	Engineer's estimate
12" FCV	12	in-dia	1	EA	$	25,000	$	25,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	RS Means
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	LS	$	10,000	$	10,000	regrading, etc Engineer's estimate
Budd Ave Facilities									
24", MLCSP, 12' Cover	24	in-dia	1,630	LF	$	477	$	778,000	80 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	5%		1	LS	$	38,900	$	39,000	9' to 14' of cover
Potholing			16	EA	$	3,600	$	59,000	Light Urban, $3,600 per 100 feet of pipe
24" BFV	24	in-dia	2	EA	$	18,055	$	36,000	Rs Means
30" BFV	30	in-dia	2	EA	$	22,000	$	44,000	Engineer's estimate
18" Meter	18	in-dia	1	EA	$	20,000	$	20,000	Engineer's estimate
18" FCV	18	in-dia	1	EA	$	40,000	$	40,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	10,000	$	10,000	regrading, etc Engineer's estimate
Kirk Ditch Facilities									
36", MLCSP, 12' Cover	36	in-dia	40	Allow	$	545	$	22,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	1,100	$	1,000	9' to 14' of cover

RMC
water and environment

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

				Quantity	Unit	Value	Cost	Notes
	Potholing			0	EA	$ 1,200	$ -	Rural, $1,200 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
16 - Electrical							**$ 60,000**	
	Electrical Allowance			4	EA	$15,000	$ 60,000	Engineers Estimate
17 - I&C							**$ 40,000**	
	I&C Allowance			4	EA	$10,000	$ 40,000	Engineers Estimate

ANNUAL O&M COSTS		**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables					**$ 10,000**	
	Mechanical	2%		$487,000	$ 10,000	2% of Valves and Meters
Labor Costs					**$ 315,000**	
	Pond Maintenance	68	AC	$4,531	$ 307,000	Engineer's estimate
	Annual Inspection and Maintenance of Pipeline - Average Annual Operator Hours per Year	47	HR	$175	$ 8,000	Engineer's estimate

Portfolio 2b cost estimate details

Table 1-40. Combined Regional AWPF in Sunnyvale; 24 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 2b)

Focus: **Cost Summary**
Element: **AWPF**
Capacity / Treatment: **24.5 mgd**
Location: Sunnyvale

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	129,000,000
Contingency - Treatment Facility	25%	$	32,000,000
Construction Cost Subtotal		$	161,000,000
Tax on Materials (applied to half of subtotal)	9%	$	8,000,000
General Contractor Overhead and Profit	15%	$	25,000,000
Estimated Total Construction Cost		**$**	**194,000,000**
Owner's Reserve for Change Orders	15%	$	30,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	30,000,000
Construction Management	13%	$	26,000,000
Engineering Services During Construction	12%	$	24,000,000
Total Capital Cost		**$**	**304,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,490,000
Energy/Power	$	5,350,000
Chemicals	$	2,890,000
Labor	$	2,800,000
Total Annual O&M Cost	**$**	**13,530,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	169,000,000
30-yr Lifecycle (present value, $2019)	$	73,000,000

*See Attachment C, Basis of Cost for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	15,510,000
Annual O&M Cost		$	13,530,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	2,430,000
Total Annual Cost		**$**	**31,470,000**
Annual Yield	AF		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,710**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	11,715,600	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	7,845,400	6%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	750,000	1%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	1,000,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	4,097,300	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	16,389,200	13%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	3,932,600	3%
Division 32 – Exterior Improvements	$	130,300	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	16,547,700	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	18,498,600	14%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	47,964,000	37%
TOTAL	**$**	**129,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF**
Capacity: **24.5 mgd**
Location: **Sunnyvale**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$117,155,100	10% of Divisions 2-47	$ 11,715,600	
Division 31 – Earthwork	Sitework	Site Clear and Grub		8	Acre		$ 7,760			$ 64,100	
Division 31 – Earthwork	Sitework	Strip Topsoil		0	SY		$ 0.85			$ -	This cost is assumed to be included in the site specific site prep. for Recycle Hill.
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		0	CY		$ 8.88			$ -	This cost is assumed to be included in the site specific site prep. for Recycle Hill.
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		0	CY		$ 1.04			$ -	This cost is assumed to be included in the site specific site prep. for Recycle Hill.
Division 31 – Earthwork	Sitework	Excavation		43,416	CY		$ 11.78			$ 511,500	
Division 31 – Earthwork	Sitework	Site Specific Site Prep. for Recycle Hill		1	LS			See Note		See Note	Site-specific prep work for Recycle Hill included in costs at the portfolio level (See App A-1, Table D-11). Based on estimate prepared by City of Sunnyvale staff in 2016. The original estimate was rounded up to $40 million and escalated to 2019 dollars. This cost is not subject to construction markup/escalation factors.
Division 31 – Earthwork	Sitework	Compaction		19,965	CY		$ 0.89			$ 17,800	
Division 31 – Earthwork	Sitework	Grading		39,930	SY		$ 1.18			$ 47,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0.25	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0.02	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		14,084	CY		$ 58.49			$ 823,800	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		9,479	SY		$ 4.63			$ 43,900	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 179,539		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 179,600	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,075,269			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,075,300	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		500	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 187,300	Unit cost was obtained by interpolating available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 187,300	9' to 14' of cover	$ 9,400	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		5	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 6,200	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin

Focus: **Cost Inputs and R&R**
Aspect: **AWPF**
Capacity: **24.5 mgd**
Location: **Sunnyvale**

Date: 2/5/2020
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Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		5,622	CY		$ 645		See Site Work and Concrete Tab	$ 3,626,200	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,460	LF		$ 52.94			$ 130,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP

Brown AND Caldwell

Focus:	**Cost Inputs and R&R**
Aspect:	**AWPF**
Capacity:	**24.5 mgd**
Location:	**Sunnyvale**

Date:	2/5/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Estimate Date:	R. Guillen
Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Lime Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		75,900	SF		$ 218.58		330' x 230'; furnished and installed	$ 16,590,100	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks

Focus:	**Cost Inputs and R&R**
Aspect:	**AWPF**
Capacity:	**24.5 mgd**
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Storage Silos	17,500	2	EA	$ 183,750				$ 367,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Slurry Batching Tank	2,000	2	EA	$ 5,793				$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Slurry Storage Tank	10,000	2	EA	$ 105,000				$ 210,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 47,964,000	30% of Equipment Costs	$ 14,389,200	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 47,964,000	30% of Equipment Costs	$ 14,389,200	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 16,389,200	25% of Electrical Costs	$ 4,097,300	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,220,000	2% of Pumping Equipment Cost	$ 24,400	
O&M	Consumables	Electrical Consumables		2%	% of			$ 16,389,200	2% of Electrical Cost	$ 327,800	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 4,097,300	2% of Instrumentation & Controls Cost	$ 82,000	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Waste Equalization Pumps		196,049	kWh		$ 0.10			$ 20,300	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF**
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Lime		877,226	lb		$ 0.15		based on 12 mg/L dose	$ 131,500	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		6,240	hours/yr		$ 163.20			$ 1,018,400	Assumes three plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 1-41. PL-8, 36-inch effluent pipeline from Palo Alto RWQCP to Sunnyvale AWPF (Portfolio 2b)

HydroScience

Project:	**Countywide Water Reuse Master Plan**				Date:	2/4/2020
					Project Number:	437-001-105
Aspect:	**PL-8. Effluent PL, Palo Alto RWQCP to Sunnyvale AWPF**	**Diam**	**36**	**inch**	Prepared By:	I Wald
		Length	**52,950**	**feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

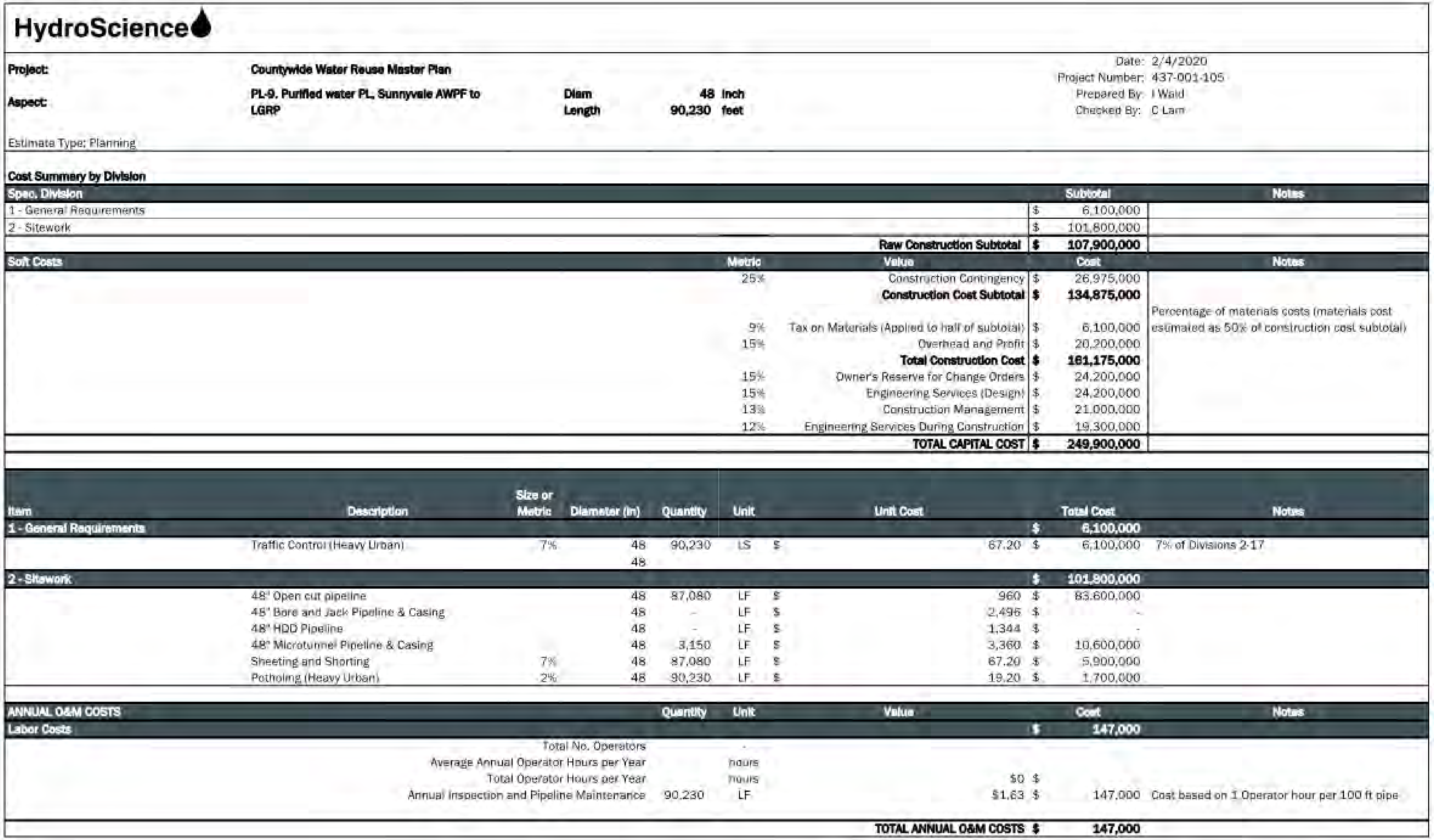
Spec. Division			Subtotal	Notes
1 - General Requirements		$	2,600,000	
2 - Sitework		$	41,800,000	
	Raw Construction Subtotal	**$**	**44,400,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	11,100,000	
		Construction Cost Subtotal	**$**	**55,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	2,500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	8,300,000	
		Total Construction Cost	**$**	**66,300,000**	
	15%	Owner's Reserve for Change Orders	$	9,900,000	
	15%	Engineering Services (Design)	$	9,900,000	
	13%	Construction Management	$	8,600,000	
	12%	Engineering Services During Construction	$	8,000,000	
		TOTAL CAPITAL COST	**$**	**102,700,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**2,600,000**	
	Traffic Control (Heavy Urban)	7%	36	51,800	LS	$	50.40	$	2,600,000	7% of Divisions 2-17
			36							
2 - Sitework								**$**	**41,800,000**	
	36" Open cut pipeline		36	51,800	LF	$	720	$	37,300,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$	1,872	$	-	
	36" HDD Pipeline		36	1,150	LF	$	1,008	$	1,200,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$	2,520	$	-	
	Sheeting and Shorting	7%	36	50,650	LF	$	50.40	$	2,600,000	
	Potholing (Heavy Urban)	2%	36	51,800	LF	$	14.40	$	700,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**86,000**	
Annual Inspection and Pipeline Maintenance	52,950	LF	$1.63	$	86,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**86,000**	

Table 1-42. PL-9, 48-inch purified water pipeline from Sunnyvale AWPF to LGRP (Portfolio 2b)



HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PL-9. Purified water PL, Sunnyvale AWPF to LGRP**

Diam **48** **inch**

Length **90,230** **feet**

Date: 2/4/2020
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Metric	Value	Subtotal	Notes
1 - General Requirements			$ 6,100,000	
2 - Sitework			$ 101,800,000	
		Raw Construction Subtotal	**$ 107,900,000**	
Soft Costs	**Metric**	**Value**	**Cost**	**Notes**
	25%	Construction Contingency	$ 26,975,000	
		Construction Cost Subtotal	**$ 134,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 6,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 20,200,000	
		Total Construction Cost	**$ 161,175,000**	
	15%	Owner's Reserve for Change Orders	$ 24,200,000	
	15%	Engineering Services (Design)	$ 24,200,000	
	13%	Construction Management	$ 21,000,000	
	12%	Engineering Services During Construction	$ 19,300,000	
		TOTAL CAPITAL COST	**$ 249,900,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 6,100,000**	
	Traffic Control (Heavy Urban)	7%	48	90,230	LS	$ 67.20	$ 6,100,000	7% of Divisions 2-17
			48					
2 - Sitework							**$ 101,800,000**	
	48" Open cut pipeline		48	87,080	LF	$ 960	$ 83,600,000	
	48" Bore and Jack Pipeline & Casing		48	-	LF	$ 2,496	$ -	
	48" HDD Pipeline		48	-	LF	$ 1,344	$ -	
	48" Microtunnel Pipeline & Casing		48	3,150	LF	$ 3,360	$ 10,600,000	
	Sheeting and Shorting	7%	48	87,080	LF	$ 67.20	$ 5,900,000	
	Potholing (Heavy Urban)	2%	48	90,230	LF	$ 19.20	$ 1,700,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 147,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$	
Annual Inspection and Pipeline Maintenance	90,230	LF	$1.63	$ 147,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 147,000**	

Table 1-43. PS-6, pump station to convey Palo Alto RWQCP effluent to Sunnyvale AWPF (Portfolio 2b)

HydroScience

Project:	**Countywide Water Reuse Master Plan**					Date:	1/30/2020
						Project Number:	437-001-105
Aspect:	**PS-6. Effluent from PA RWQCP to Sunnyvale AWPF**	**Flow**	**12,000**	**gpm**		Prepared By:	I Wald
		TDH	**100**	**feet**		Checked By:	C Lam
		Horsepower	**508**	**hp**		Check Date:	
Estimate Type: Planning							

Cost Summary by Division

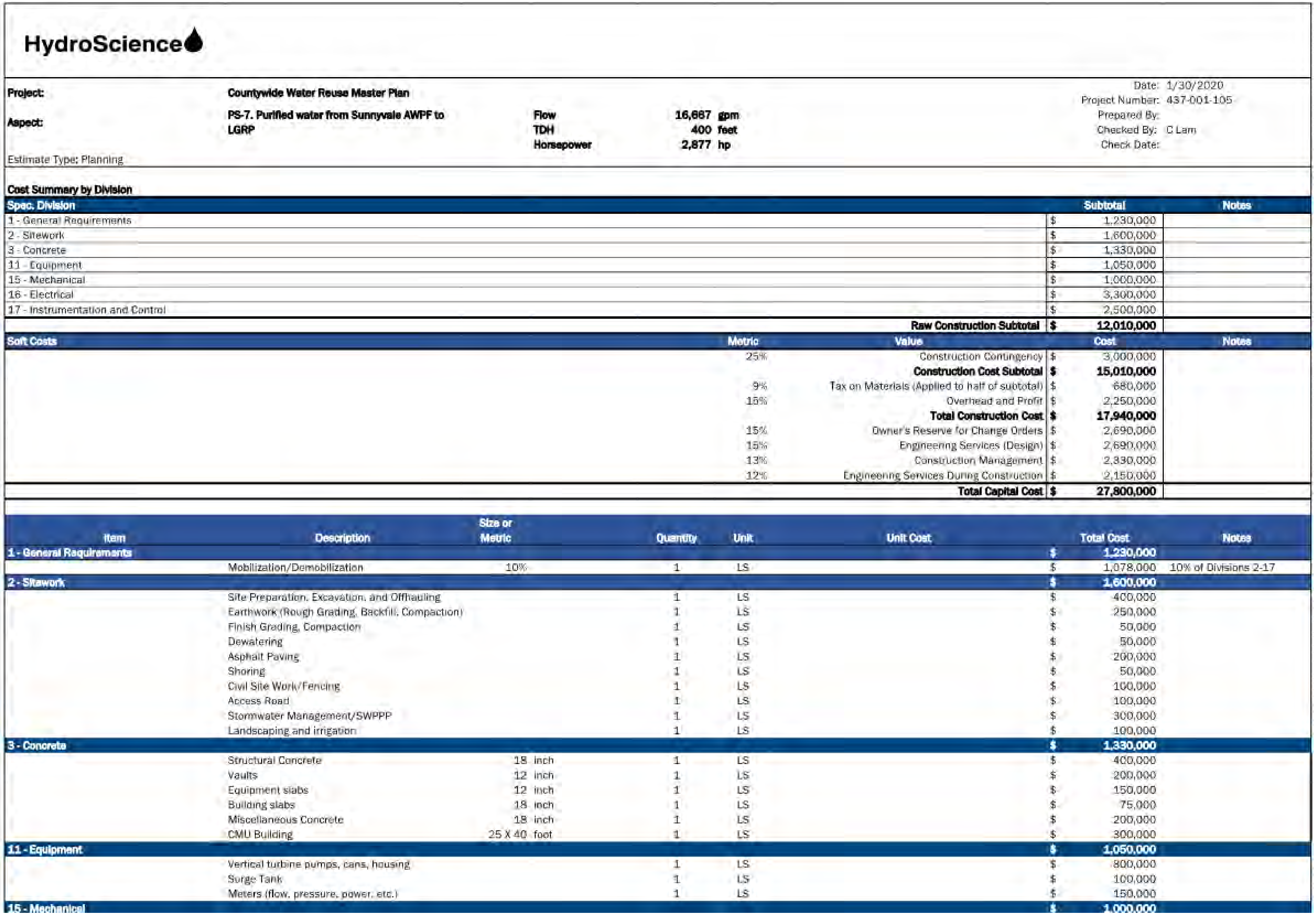
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 260,000	
2 - Sitework	$ 290,000	
3 - Concrete	$ 250,000	
15 - Mechanical	$ 125,000	
16 - Electrical	$ 250,000	
17 - Instrumentation and Control	$ 300,000	
Raw Construction Subtotal	**$ 1,900,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 480,000	
		Construction Cost Subtotal	**$ 2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 110,000	
	15%	Overhead and Profit	$ 360,000	
		Total Construction Cost	**$ 2,850,000**	
	15%	Owner's Reserve for Change Orders	$ 430,000	
	15%	Engineering Services (Design)	$ 430,000	
	13%	Construction Management	$ 370,000	
	12%	Engineering Services During Construction	$ 340,000	
		TOTAL CAPITAL COST	**$ 4,420,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 260,000**	
	Mobilization/Demobilization	10%	1	LS		$ 164,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 100,000	
2 - Sitework						**$ 290,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 50,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 25,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 40,000	
3 - Concrete						**$ 250,000**	
	Structural Concrete	18 inch	1	LS		$ 100,000	
	Vaults	12 inch	1	LS		$ 60,000	
	Equipment slabs	12 inch	1	LS		$ 40,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 50,000	
11 - Equipment						**$ 425,000**	
	Pump		1	LS		$ 250,000	
	Surge Tank		1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 125,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						**$ 250,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 250,000	
17 - I&C						**$ 300,000**	
	I&C/SCADA/Programming Allowance					$ 300,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 22,000**	
	Equipment		2%		$425,000	$ 8,500	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$300,000	$ 6,000	2% of Division 17
Power Costs						**$ 332,000**	
	Electricity Requirement	508 hp	1,749,177	kWh	$0.19	$ 332,000	
					TOTAL ANNUAL O&M COSTS	**$ 354,000**	

Table 1-44. PS-7, pump station to convey Sunnyvale AWPF purified water to LGRP (Portfolio 2b)



HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	1/30/2020
Aspect:	**PS-7. Purified water from Sunnyvale AWPF to LGRP**	**Flow**	**16,667 gpm**	Project Number:	437-001-105
		TDH	**400 feet**	Prepared By:	
		Horsepower	**2,877 hp**	Checked By:	C Lam
Estimate Type: Planning				Check Date:	

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 1,230,000	
2 - Sitework	$ 1,600,000	
3 - Concrete	$ 1,330,000	
11 - Equipment	$ 1,050,000	
15 - Mechanical	$ 1,000,000	
16 - Electrical	$ 3,300,000	
17 - Instrumentation and Control	$ 2,500,000	
Raw Construction Subtotal	**$ 12,010,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,000,000	
		Construction Cost Subtotal	**$ 15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 680,000	
	15%	Overhead and Profit	$ 2,250,000	
		Total Construction Cost	**$ 17,940,000**	
	15%	Owner's Reserve for Change Orders	$ 2,690,000	
	15%	Engineering Services (Design)	$ 2,690,000	
	13%	Construction Management	$ 2,330,000	
	12%	Engineering Services During Construction	$ 2,150,000	
		Total Capital Cost	**$ 27,800,000**	

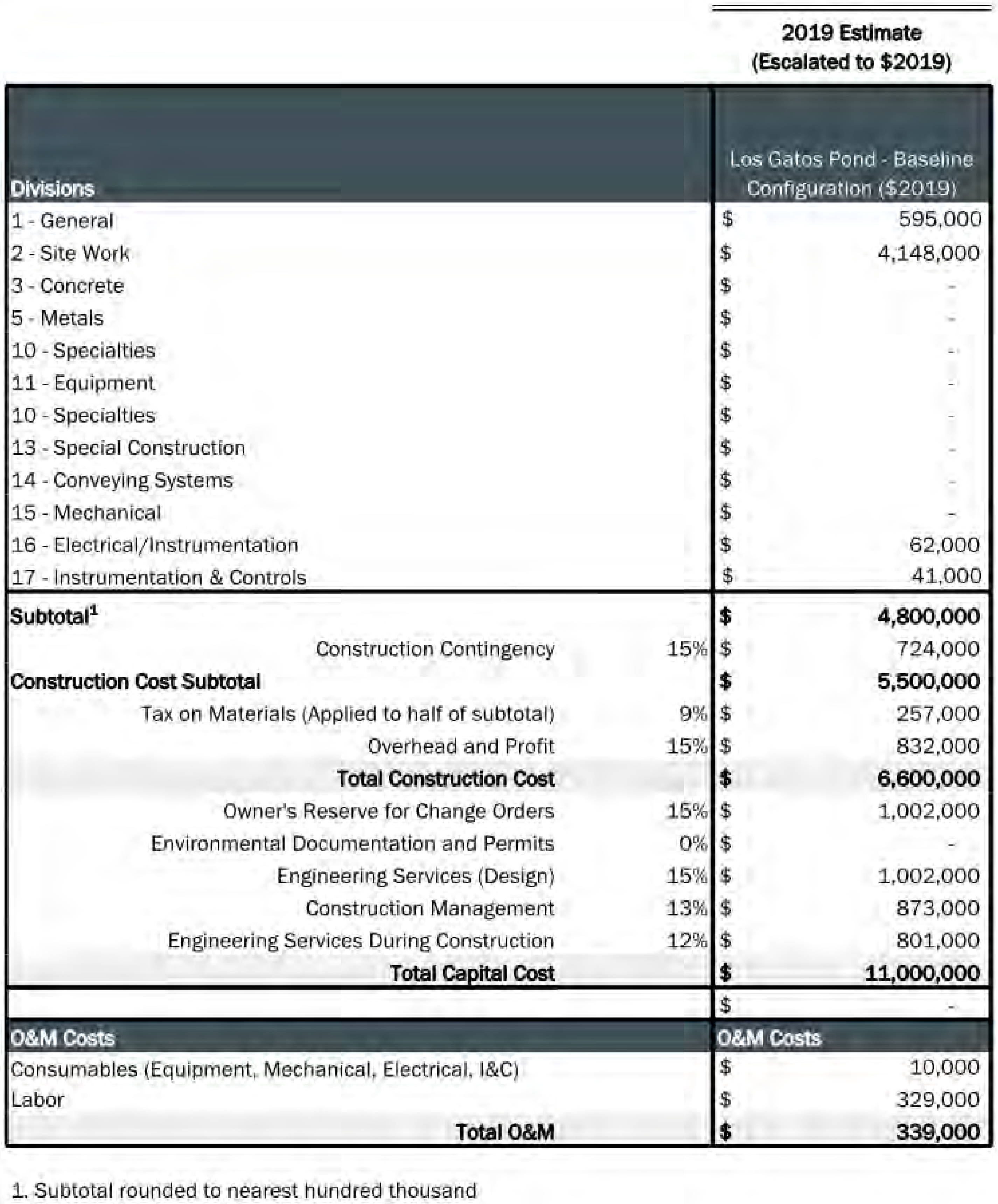
Item	Description	Size or Metric		Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 1,230,000**	
	Mobilization/Demobilization	10%		1	LS		$ 1,078,000	10% of Divisions 2-17
2 - Sitework							**$ 1,600,000**	
	Site Preparation, Excavation, and Offhauling			1	LS		$ 400,000	
	Earthwork (Rough Grading, Backfill, Compaction)			1	LS		$ 250,000	
	Finish Grading, Compaction			1	LS		$ 50,000	
	Dewatering			1	LS		$ 50,000	
	Asphalt Paving			1	LS		$ 200,000	
	Shoring			1	LS		$ 50,000	
	Civil Site Work/Fencing			1	LS		$ 100,000	
	Access Road			1	LS		$ 100,000	
	Stormwater Management/SWPPP			1	LS		$ 300,000	
	Landscaping and irrigation			1	LS		$ 100,000	
3 - Concrete							**$ 1,330,000**	
	Structural Concrete	18	inch	1	LS		$ 400,000	
	Vaults	12	inch	1	LS		$ 200,000	
	Equipment slabs	12	inch	1	LS		$ 150,000	
	Building slabs	18	inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18	inch	1	LS		$ 200,000	
	CMU Building	25 X 40	foot	1	LS		$ 300,000	
11 - Equipment							**$ 1,050,000**	
	Vertical turbine pumps, cans, housing			1	LS		$ 800,000	
	Surge Tank			1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)			1	LS		$ 150,000	
15 - Mechanical							**$ 1,000,000**	

Brown AND Caldwell

Item	Description	Size or Metric		Quantity	Unit	Unit Cost	Total Cost	Notes
	Water/Sewer/Storm Utility improvements			1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances			1	LS		$ 800,000	
16 - Electrical							**$ 3,300,000**	
	Electrical Allowance (MCC, wiring, panels)			1	LS		$ 2,500,000	
	Standby generator			1	LS		$ 800,000	
17 - I&C							**$ 2,500,000**	
	I&C/SCADA/Programming Allowance						$ 2,500,000	
ANNUAL O&M COSTS				**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables							**$ 157,000**	
	Equipment			2%		$1,050,000	$ 21,000	2% of Division 11
	Mechanical			2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical			2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation			2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs							**$ 1,516,000**	
	Electricity Requirement	2,877	hp	9,474,391	kWh	$0.16	$ 1,516,000	
						TOTAL ANNUAL O&M COSTS	**$ 1,673,000**	

Brown AND Caldwell

Table 1-45. LGRP site improvements (Portfolio 2b)



Divisions		2019 Estimate (Escalated to $2019) Los Gatos Pond - Baseline Configuration ($2019)
1 - General		$ 595,000
2 - Site Work		$ 4,148,000
3 - Concrete		$ -
5 - Metals		$ -
10 - Specialties		$ -
11 - Equipment		$ -
10 - Specialties		$ -
13 - Special Construction		$ -
14 - Conveying Systems		$ -
15 - Mechanical		$ -
16 - Electrical/Instrumentation		$ 62,000
17 - Instrumentation & Controls		$ 41,000
Subtotal[1]		**$ 4,800,000**
Construction Contingency	15%	$ 724,000
Construction Cost Subtotal		**$ 5,500,000**
Tax on Materials (Applied to half of subtotal)	9%	$ 257,000
Overhead and Profit	15%	$ 832,000
Total Construction Cost		**$ 6,600,000**
Owner's Reserve for Change Orders	15%	$ 1,002,000
Environmental Documentation and Permits	0%	$ -
Engineering Services (Design)	15%	$ 1,002,000
Construction Management	13%	$ 873,000
Engineering Services During Construction	12%	$ 801,000
Total Capital Cost		**$ 11,000,000**
		$ -
O&M Costs		**O&M Costs**
Consumables (Equipment, Mechanical, Electrical, I&C)		$ 10,000
Labor		$ 329,000
Total O&M		**$ 339,000**

1. Subtotal rounded to nearest hundred thousand

RMC
water and environment

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 579,000	
2 - Sitework	$ 4,037,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 40,000	
Subtotal	$ 4,716,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost (2017 $)	Notes
1 - General Requirements							**$ 579,000**	
	Mobilization	10%		1	LS	$413,700	$ 414,000	10% of Divisions 2-17
	Traffic Control	4%		1	LS	$165,480	$ 165,000	Assumed average traffic control was light urban
2 - Sitework							**$ 4,037,000**	
	Page Pond Facilities							
	36", MLCSP, 12' Cover	36	in-dia	1,800	LF	$ 545	$ 980,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 49,000	$ 49,000	9' to 14' of cover
	Potholing			18	EA	$ 6,000	$ 108,000	Heavy Urban, $6,000 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
	Sunnyoaks Facilities							
	18", PVC, 8' Cover	18	in-dia	1,180	LF	$ 334	$ 394,000	100 ft/d production, Full lane AC, bell and spigot installation, 100% import
	Sheeting and Shoring (Open Cut)	3%		1	LS	$ 11,820	$ 12,000	Up to 8' of cover
	Potholing			12	EA	$ 3,600	$ 42,000	Light Urban, $3,600 per 100 feet of pipe

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

30", MLCSP, 12' Cover	30	in-dia	120	LF	$	430	$	52,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	2,600	$	3,000	9' to 14' of cover
Potholing			1	EA	$	6,000	$	7,000	Heavy Urban, $6,000 per 100 feet of pipe
18" BFV	18	in-dia	2	EA	$	8,579	$	17,000	Rs Means
12" Meter	12	in-dia	1	EA	$	15,000	$	15,000	Engineer's estimate
12" FCV	12	in-dia	1	EA	$	25,000	$	25,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	RS Means
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	LS	$	10,000	$	10,000	regrading, etc Engineer's estimate
Budd Ave Facilities									
24", MLCSP, 12' Cover	24	in-dia	1,630	LF	$	477	$	778,000	80 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	5%		1	LS	$	38,900	$	39,000	9' to 14' of cover
Potholing			16	EA	$	3,600	$	59,000	Light Urban, $3,600 per 100 feet of pipe
24" BFV	24	in-dia	2	EA	$	18,055	$	36,000	Rs Means
30" BFV	30	in-dia	2	EA	$	22,000	$	44,000	Engineer's estimate
18" Meter	18	in-dia	1	EA	$	20,000	$	20,000	Engineer's estimate
18" FCV	18	in-dia	1	EA	$	40,000	$	40,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	10,000	$	10,000	regrading, etc Engineer's estimate
Kirk Ditch Facilities									
36", MLCSP, 12' Cover	36	in-dia	40	Allow	$	545	$	22,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	1,100	$	1,000	9' to 14' of cover

RMC
water and environment

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

Potholing			0	EA	$ 1,200	$ -	Rural, $1,200 per 100 feet of pipe
36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
Vault Box			1	EA	$ 10,116	$ 10,000	
Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
16 - Electrical						**$ 60,000**	
Electrical Allowance			4	EA	$15,000	$ 60,000	Engineers Estimate
17 - I&C						**$ 40,000**	
I&C Allowance			4	EA	$10,000	$ 40,000	Engineers Estimate

ANNUAL O&M COSTS	**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables				**$ 10,000**	
Mechanical	2%		$487,000	$ 10,000	2% of Valves and Meters
Labor Costs				**$ 315,000**	
Pond Maintenance	68	AC	$4,531	$ 307,000	Engineer's estimate
Annual Inspection and Maintenance of Pipeline - Average Annual Operator Hours per Year	47	HR	$175	$ 8,000	Engineer's estimate

Portfolio 4 cost estimate details

Table 1-46. Separate Regional AWPF in Palo Alto; 14 mgd for GWR (Portfolio 4)

Focus: **Cost Summary**
Aspect: **AWPF (1 of 2)**
Capacity: **14 mgd**
Location: **Palo Alto**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	83,000,000
Contingency - Treatment Facility	25%	$	21,000,000
Construction Cost Subtotal		$	104,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	16,000,000
Estimated Total Construction Cost		**$**	**125,000,000**
Owner's Reserve for Change Orders	15%	$	19,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	19,000,000
Construction Management	13%	$	17,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**195,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	1,440,000
Energy/Power	$	3,200,000
Chemicals	$	1,680,000
Labor	$	2,100,000
Total Annual O&M Cost	**$**	**8,420,000**

Replacement and Renewal Costs		
100-yr Lifecycle (present value, $2019)	$	108,000,000
30-yr Lifecycle (present value, $2019)	$	47,000,000

*See Attachment C, Basis of Cost for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	9,950,000
Annual O&M Cost		$	8,420,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	1,570,000
Total Annual Cost		**$**	**18,370,000**
Annual Yield	AF*		**10,571**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,740**

*proportional distribution of Palo Alto and Sunnyvale based on 18,500 AF modeled yield

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	7,501,400	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	5,667,500	7%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	453,200	1%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	604,200	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	2,561,500	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	10,245,900	12%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	3,755,100	5%
Division 32 – Exterior Improvements	$	111,200	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	10,441,200	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	10,909,700	13%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	30,263,700	36%
TOTAL	**$**	**83,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (1 of 2)**
Capacity: **14 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500	
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		35,528	CY		$ 11.78			$ 418,600	
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000	
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0.25	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0.02	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		11,143	CY		$ 58.49			$ 651,800	
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500	
Division 31 – Earthwork	Sitework	Gravel		15,533	SY		$ 4.63			$ 72,000	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 50,000	Engineer's estimate for water, internet, sewer connections	$ 50,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 1,166,667	24 Mgd is $2,000,000, scaled down	$ 1,166,700	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		1,414	SF		$ 141.20		Assumes (2) 30' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 199,700	Inter Process Tank
Division 31 – Earthwork	Sitework	10-inch Waste Pipeline		1,200	LF			$ 324.94	10-inch, HDPE, 11' Cover	$ 390,000	Unit cost was obtained by interpolating using available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 390,000	9' to 14' of cover	$ 19,500	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,259	CY		$ 645		See Site Work and Concrete	$ 812,300	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		630	CY		$ 1,150		See Site Work and Concrete	$ 724,100	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		660	CY		$ 1,090		See Site Work and Concrete	$ 719,400	EQ Basin
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		135	CY		$ 645		See Site Work and Concrete	$ 86,800	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		127	CY		$ 645		See Site Work and Concrete	$ 81,700	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		41	CY		$ 645		See Site Work and Concrete	$ 26,400	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		379	CY		$ 645		See Site Work and Concrete	$ 244,700	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		3,259	CY		$ 645		See Site Work and Concrete	$ 2,102,100	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		30	CY		$ 645		See Site Work and Concrete	$ 19,200	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		27	CY		$ 645		See Site Work and Concrete	$ 17,200	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		53	CY		$ 645		See Site Work and Concrete	$ 34,400	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		150	CY		$ 1,090		See Site Work and Concrete	$ 163,500	Waste Equalization Wetwell & Pump Station

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (1 of 2)**
Capacity: **14 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B Adjusted Unit	Cost Method C Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Piping Slab		20	CY		$ 645		See Site Work and Concrete	$ 12,700	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 52.94			$ 111,200	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$453,125	Engineer's Estimate	$ 453,200	Scaled from the 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$604,167	Engineer's Estimate	$ 604,200	Scaled from the 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	6	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 285,300	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 5,745,539			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 5,745,600	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	10,000	1				$70,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 70,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	100	5	EA	$ 47,545				$ 237,800	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 16,434,000			October 2019 Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 16,434,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	3	EA	$ 29,364				$ 88,100	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			scaled 5/4/17 proposal from Daniel Mechanical includes (3) decarbonator towers, flow distributor system, media, fan system down by one unit	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	3	EA	$ 35,424				$ 106,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 5,088,790			1 duty, 1 standby 14 mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 5,088,800	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Calcium Chloride Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	3	EA	$ 37,950				$ 113,900	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		44,000	SF		$ 218.58		220' x 200'; furnished and installed	$ 9,617,500	Process Building

Focus:	Cost Inputs and R&R	Date:	2/5/2020
Aspect:	AWPF (1 of 2)	BC Project Number:	151772
Capacity:	14 mgd	Estimate Version Number:	2.0
Location:	Palo Alto	Prepared by:	R. Guillen
		Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost Total	Notes
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.50	EA		$ 534,375		Need two tanks (approx 95,000 gallons each) assume 1/2 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 267,200	Storage Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC costs (linear interpolation; unit cost based on 454 sf)
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Calcium Chloride Tank (Carbon Steel, Vert.)	10,000	2	EA	$ 120,000			Assumes 30 day storage	$ 240,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 - Process Integration	Mechanical	Piping allowance		30%	% of			$30,263,700	30% of Equipment Costs	$ 9,079,200	
Division 40 - Process Integration	Mechanical	Valve allowance		5%	% of			$9,079,200	5% of Piping Allowance	$ 454,000	
Division 40 - Process Integration	Mechanical	Fitting allowance		5%	% of			$9,079,200	5% of Piping Allowance	$ 454,000	
Division 40 - Process Integration	Mechanical	Supports allowance		5%	% of			$9,079,200	5% of Piping Allowance	$ 454,000	
Division 26 - Electrical	Electrical	Electrical Allowance		30%	% of			$30,263,700	30% of Equipment Costs	$ 9,079,200	
Division 17 - Instrumentation	I&C	I&C Allowance		25%	% of			$10,245,900	25% of Electrical Costs	$ 2,561,500	
O&M	Consumables	UF Membranes Replacement		450	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 891,200	
O&M	Consumables	RO Membranes Replacement		554	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 192,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		245	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 48,100	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		34	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 26,700	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,071,100	2% of Pumping Equipment Cost	$ 21,500	
O&M	Consumables	Electrical Consumables		2%	% of			$ 10,245,900	2% of Electrical Cost	$ 205,000	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,561,500	2% of Instrumentation & Controls Cost	$ 51,300	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (1 of 2)**
Capacity: **14 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Power	Influent Pumps		3,267,480	kWh		$ 0.10			$ 338,100	
O&M	Power	UF Air Scour		4,555	kWh		$ 0.10			$ 500	
O&M	Power	UF CIP		5,957	kWh		$ 0.10			$ 700	
O&M	Power	RO Transfer Pumps		3,267,480	kWh		$ 0.10			$ 338,100	
O&M	Power	RO Feed Pumps		19,604,880	kWh		$ 0.10			$ 2,028,200	
O&M	Power	RO Inter-Stage Pumps		392,098	kWh		$ 0.10			$ 40,600	
O&M	Power	RO CIP		1,417	kWh		$ 0.10			$ 200	
O&M	Power	Decarbonator Feed Pumps		490,122	kWh		$ 0.10			$ 50,800	
O&M	Power	Decarbonator Blowers		392,098	kWh		$ 0.10			$ 40,600	
O&M	Power	UV/AOP Transfer Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	UV System		1,909,680	kWh		$ 0.10			$ 197,600	
O&M	Power	RO Concentrate Waste Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Waste Equalization Pumps		130,699	kWh		$ 0.10			$ 13,600	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		30,100	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 67,800	scaled down from 24 mgd flow
O&M	Chemicals	Aq. Ammonia		18,083	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 1,800	scaled down from 24 mgd flow
O&M	Chemicals	Citric Acid		2,100	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 11,700	scaled down from 24 mgd flow
O&M	Chemicals	Hydrogen Peroxide		35,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 179,900	scaled down from 24 mgd flow
O&M	Chemicals	Sodium Hydroxide		56,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 161,500	scaled down from 24 mgd flow
O&M	Chemicals	Sodium Hypochlorite		1,233,167	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 752,300	scaled down from 24 mgd flow
O&M	Chemicals	Calcium Chloride		140,000	gal		$ 0.54		Costs based on Expedited Purified Water Program Estimates	$ 76,300	scaled down from 24 mgd flow
O&M	Chemicals	Sulfuric Acid		15,680	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 15,700	scaled down from 24 mgd flow
O&M	Chemicals	RO Antiscalant		15,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 316,700	scaled down from 24 mgd flow
O&M	Chemicals	RO Low pH Cleaner		11,900	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 66,300	scaled down from 24 mgd flow
O&M	Chemicals	RO High pH Cleaner		11,900	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 34,400	scaled down from 24 mgd flow
O&M	Labor	Water Plant Operator		4,160	hours/yr		$ 163.20			$ 679,000	Assumes two plant operators 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Sr Mechanics		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		2,080	hours/yr		$ 172.27			$ 358,400	Assumes one control tech 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 1-47. Separate Regional AWPF in Sunnyvale; 10 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 4)

Focus: **Cost Summary**
Element: **AWPF (2 of 2)**
Capacity: **10.5 MGD**
Location: **Sunnyvale**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	68,000,000
Contingency - Treatment Facility	25%	$	17,000,000
Construction Cost Subtotal		$	85,000,000
Tax on Materials (applied to half of subtotal)	9%	$	4,000,000
General Contractor Overhead and Profit	15%	$	13,000,000
Estimated Total Construction Cost		**$**	**102,000,000**
Owner's Reserve for Change Orders	15%	$	16,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	16,000,000
Construction Management	13%	$	14,000,000
Engineering Services During Construction	12%	$	13,000,000
Total Capital Cost		**$**	**161,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	1,150,000
Energy/Power	$	2,580,000
Chemicals	$	1,260,000
Labor	$	1,400,000
Total Annual O&M Cost	**$**	**6,390,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	90,000,000
30-yr Lifecycle (present value, $2019)	$	39,000,000

*See Attachment C, Basis of Cost for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	8,210,000
Annual O&M Cost		$	6,390,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	1,300,000
Total Annual Cost		**$**	**15,900,000**
Annual Yield	AF		**7,929**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**2,010**

*proportional distribution of Palo Alto and Sunnyvale based on 18,500 AF modeled yield

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	6,201,400	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	4,456,800	7%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	328,200	0%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	437,500	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	2,102,000	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	8,408,000	12%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	3,656,900	5%
Division 32 – Exterior Improvements	$	130,300	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	8,663,100	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	8,720,500	13%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	25,109,800	37%
TOTAL	**$**	**68,000,000**	

Focus: **Cost Inputs and R&R**
Element: **AWPF (2 of 2)**
Capacity: **10.5 MGD**
Location: **Sunnyvale**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$62,013,100	10% of Divisions 2-47	$ 6,201,400	
Division 31 – Earthwork	Sitework	Site Clear and Grub		8	Acre		$ 7,760			$ 64,100	
Division 31 – Earthwork	Sitework	Excavation		40,373	CY		$ 11.78			$ 475,600	
Division 31 – Earthwork	Sitework	Site Specific Site Prep. for Recycle Hill		1	LS			See Note		See Note	Site-specific prep work for Recycle Hill included in costs at the portfolio level (See App A-1, Table D-11). Based on estimate prepared by City of Sunnyvale staff in 2016. The original estimate was rounded up to $40 million and escalated to 2019 dollars. This cost is not subject to construction markup/escalation factors.
Division 31 – Earthwork	Sitework	Compaction		19,965	CY		$ 0.89			$ 17,800	
Division 31 – Earthwork	Sitework	Grading		39,930	SY		$ 1.18			$ 47,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0.25	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0.02	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		13,857	CY		$ 58.49			$ 810,500	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		16,063.89	SY		$ 4.63			$ 74,400	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 179,539		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 179,600	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,075,269			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,075,300	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 50,000	Engineer's estimate for water, internet, sewer connections	$ 50,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 875,000	24 mgd plant is $2,000,000, scaled down	$ 875,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		1,232	SF		$ 141.20		Assumes (2) 28' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 173,900	Inter Process Tank
Division 31 – Earthwork	Sitework	10-inch Waste Pipeline		500	LF			$ 324.94	10-inch, HDPE, 11' Cover	$ 162,500	Unit cost was obtained by interpolating using available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 162,500	9' to 14' of cover	$ 8,200	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		5	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 6,200	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,037	CY		$ 645		See Site Work and Concrete	$ 668,900	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		519	CY		$ 1,150		See Site Work and Concrete	$ 596,300	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		587	CY		$ 1,090		See Site Work and Concrete	$ 639,500	EQ Basin
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		119	CY		$ 645		See Site Work and Concrete	$ 76,900	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		107	CY		$ 645		See Site Work and Concrete	$ 68,800	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		26	CY		$ 645		See Site Work and Concrete	$ 17,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		252	CY		$ 645		See Site Work and Concrete	$ 162,500	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		407	CY		$ 645		See Site Work and Concrete	$ 262,300	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		46	CY		$ 1,090		See Site Work and Concrete	$ 50,700	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		2,607	CY		$ 645		See Site Work and Concrete	$ 1,681,600	Process Building

Focus: **Cost Inputs and R&R**
Element: **AWPF (2 of 2)**
Capacity: **10.5 MGD**
Location: **Sunnyvale**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Switchgear Slab		30	CY		$ 645		See Site Work and Concrete	$ 19,200	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		27	CY		$ 645		See Site Work and Concrete	$ 17,200	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		57	CY		$ 645		See Site Work and Concrete	$ 36,700	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		112	CY		$ 1,090		See Site Work and Concrete	$ 122,100	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete	$ 16,900	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,460	LF		$ 52.94			$ 130,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 328,125	Engineer's Estimate	$ 328,200	Scaled from the 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 437,500	Engineer's Estimate	$ 437,500	Scaled from the 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	5	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 237,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 4,596,431			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment,	$ 4,596,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	10,000	1				$70,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 70,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	100	5	EA	$ 47,545				$ 237,800	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 13,695,000			October 2019 Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 13,695,000	
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	2	EA	$ 29,364				$ 58,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			scaled 5/4/17 proposal from Daniel Mechanical includes (2) decarbonator towers, flow distributor system, media, fan system down by one unit	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	2	EA	$ 35,424				$ 70,900	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 4,003,456			1 duty, 1 standby 14 mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 4,003,500	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Lime Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing

Focus:	**Cost Inputs and R&R**
Element:	**AWPF (2 of 2)**
Capacity:	**10.5 MGD**
Location:	**Sunnyvale**

Date:	2/5/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Prepared by:	R. Guillen
Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	3	4	EA	$ 11,385				$ 45,600	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		35,200	SF		$ 219		220' x 160'; furnished and installed	$ 7,694,000	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.4	EA		$ 534,375		Need two tanks (approx 83,000 gallons each) assume 2/5 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 213,800	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 4,310			Assumes 30 day storage	$ 4,400	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	1	EA	$ 12,275			Assumes 30 day storage	$ 12,300	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 5,793			Assumes 30 day storage	$ 5,800	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 48,000			Assumes 30 day storage	$ 48,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	1	EA	$ 220,500			Assumes 7 day storage	$ 220,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 13,440			Assumes 30 day storage	$ 13,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Storage Silos	8,000	2	EA	$ 120,000				$ 240,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Slurry Batching Tank	450	2	EA	$ 4,725				$ 9,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Slurry Storage Tank	4,500	2	EA	$ 47,250				$ 94,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	1	EA	$ 12,000			Assumes 30 day storage	$ 12,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 25,109,800	30% of Equipment Costs	$ 7,533,000	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 7,533,000	5% of Piping Allowance	$ 376,700	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 7,533,000	5% of Piping Allowance	$ 376,700	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 7,533,000	5% of Piping Allowance	$ 376,700	

Focus: **Cost Inputs and R&R**
Element: **AWPF (2 of 2)**
Capacity: **10.5 MGD**
Location: **Sunnyvale**

Date: 2/5/2020
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Estimate Version Number: 2.0
Prepared by: R. Guillen
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 25,109,800	30% of Equipment Costs	$ 7,533,000	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 8,408,000	25% of Electrical Costs	$ 2,102,000	
O&M	Consumables	UF Membranes Replacement		360	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 712,900	
O&M	Consumables	RO Membranes Replacement		462	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 160,400	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		140	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 27,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		24	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 19,100	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 863,100	2% of Pumping Equipment Cost	$ 17,300	
O&M	Consumables	Electrical Consumables		2%	% of			$ 8,408,000	2% of Electrical Cost	$ 168,200	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,102,000	2% of Instrumentation & Controls Cost	$ 42,100	
O&M	Power	Influent Pumps		2,613,984	kWh		$ 0.10			$ 270,500	
O&M	Power	UF Air Scour		4,555	kWh		$ 0.10			$ 500	
O&M	Power	UF CIP		5,957	kWh		$ 0.10			$ 700	
O&M	Power	RO Transfer Pumps		2,613,984	kWh		$ 0.10			$ 270,500	
O&M	Power	RO Feed Pumps		16,337,400	kWh		$ 0.10			$ 1,690,200	
O&M	Power	RO Inter-Stage Pumps		326,748	kWh		$ 0.10			$ 33,900	
O&M	Power	RO CIP		1,181	kWh		$ 0.10			$ 200	
O&M	Power	Decarbonator Feed Pumps		326,748	kWh		$ 0.10			$ 33,900	
O&M	Power	Decarbonator Blowers		261,398	kWh		$ 0.10			$ 27,100	
O&M	Power	UV/AOP Transfer Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	UV System		1,462,920	kWh		$ 0.10			$ 151,400	
O&M	Power	RO Concentrate Waste Pumps		261,398	kWh		$ 0.10			$ 27,100	
O&M	Power	Waste Equalization Pumps		39,210	kWh		$ 0.10			$ 4,100	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		22,575	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 50,800	scaled down from 24 mgd flow
O&M	Chemicals	Aq. Ammonia		13,563	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 1,400	scaled down from 24 mgd flow
O&M	Chemicals	Citric Acid		1,575	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 8,800	scaled down from 24 mgd flow
O&M	Chemicals	Hydrogen Peroxide		26,250	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 134,900	scaled down from 24 mgd flow
O&M	Chemicals	Sodium Hydroxide		42,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 121,100	scaled down from 24 mgd flow
O&M	Chemicals	Sodium Hypochlorite		924,875	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 564,200	scaled down from 24 mgd flow

Table 1-48. PL-5, 36-inch effluent pipeline from Palo Alto RWQCP to Palo Alto AWPF (Portfolio 4)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	2/4/2020
Aspect:	**PL-5. Effluent PL from Palo Alto RWQCP to Palo Alto AWPF**	**Diam**	**36 inch**	Project Number:	437-001-105
		Length	**15,150 feet**	Prepared By:	I Wald
				Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Metric	Value		Subtotal	Notes
1 - General Requirements			$	700,000	
2 - Sitework			$	12,000,000	
		Raw Construction Subtotal	**$**	**12,700,000**	
Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	3,175,000	
		Construction Cost Subtotal	**$**	**15,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	2,400,000	
		Total Construction Cost	**$**	**18,975,000**	
	15%	Owner's Reserve for Change Orders	$	2,800,000	
	15%	Engineering Services (Design)	$	2,800,000	
	13%	Construction Management	$	2,500,000	
	12%	Engineering Services During Construction	$	2,300,000	
		TOTAL CAPITAL COST	**$**	**29,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**700,000**	
	Traffic Control (Heavy Urban)	7%	36	14,500	LS	$	50.40	$	700,000	7% of Divisions 2-17
			36							
2 - Sitework								**$**	**12,000,000**	
	36" Open cut pipeline		36	14,500	LF	$	720	$	10,400,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$	1,872	$	-	
	36" HDD Pipeline		36	650	LF	$	1,008	$	700,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$	2,520	$	-	
	Sheeting and Shorting	7%	36	14,500	LF	$	50.40	$	700,000	
	Potholing (Heavy Urban)	2%	36	14,500	LF	$	14.40	$	200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**25,000**	
Total No. Operators		-				
Average Annual Operator Hours per Year		hours				
Total Operator Hours per Year		hours	$0	$	-	
Annual Inspection and Pipeline Maintenance	15,150	LF	$1.63	$	25,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**25,000**	

Table 1-49. PL-10, 36-inch purified water pipeline from Palo Alto AWPF to mid-point connecting to Joint Purified Water Pipeline (Portfolio 4)

HydroScience

Project:	**Countywide Water Reuse Master Plan**				Date:	2/4/2020
					Project Number:	437-001-105
Aspect:	**PL-10. Purified water PL, Palo Alto AWPF to Joint Purified Water PL**	**Diam**	**36**	**Inch**	Prepared By:	I Wald
		Length	**34,500**	**feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,700,000	
2 - Sitework	$	27,300,000	
Raw Construction Subtotal	**$**	**29,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	7,250,000	
		Construction Cost Subtotal	**$**	**36,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	5,400,000	
		Total Construction Cost	**$**	**43,250,000**	
	15%	Owner's Reserve for Change Orders	$	6,500,000	
	15%	Engineering Services (Design)	$	6,500,000	
	13%	Construction Management	$	5,600,000	
	12%	Engineering Services During Construction	$	5,200,000	
		TOTAL CAPITAL COST	**$**	**67,100,000**	

Item	Description	Size or Metric	Diameter (In)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**1,700,000**	
	Traffic Control (Heavy Urban)	7%	36	34,500	LS	$	50.40	$	1,700,000	7% of Divisions 2-17
			36							
2 - Sitework								**$**	**27,300,000**	
	36" Open cut pipeline		36	33,650	LF	$	720	$	24,200,000	
	36" Bore and Jack Pipeline & Casing		36		LF	$	1,872	$	-	
	36" HDD Pipeline		36	850	LF	$	1,008	$	900,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$	2,520	$	-	
	Sheeting and Shorting	7%	36	33,650	LF	$	50.40	$	1,700,000	
	Potholing (Heavy Urban)	2%	36	34,500	LF	$	14.40	$	500,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**56,000**	
Total No. Operators		-				
Average Annual Operator Hours per Year		hours				
Total Operator Hours per Year		hours	$0	$		
Annual Inspection and Pipeline Maintenance	34,500	LF	$1.63	$	56,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**56,000**	

Table 1-50. PL-11, 48-inch purified water pipeline from Joint Purified Water Pipeline to LGRP (Portfolio 4)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	2/4/2020
				Project Number:	437-001-105
Aspect:	**PL-11. Joint Purified Water PL (at Arques) to LGRP**	**Diam**	**48 Inch**	Prepared By:	I Wald
		Length	**72,500 feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Metric	Value		Subtotal / Cost	Notes
1 - General Requirements			$	4,900,000	
2 - Sitework			$	76,500,000	
		Raw Construction Subtotal	**$**	**81,400,000**	
Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	20,350,000	
		Construction Cost Subtotal	**$**	**101,750,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	4,600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	15,300,000	
		Total Construction Cost	**$**	**121,650,000**	
	15%	Owner's Reserve for Change Orders	$	18,200,000	
	15%	Engineering Services (Design)	$	18,200,000	
	13%	Construction Management	$	15,800,000	
	12%	Engineering Services During Construction	$	14,600,000	
		TOTAL CAPITAL COST	**$**	**188,500,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**4,900,000**	
	Traffic Control (Heavy Urban)	7%	48	72,500	LS	$	67.20	$	4,900,000	7% of Divisions 2-17
2 - Sitework								**$**	**76,500,000**	
	48" Open cut pipeline		48	70,350	LF	$	960	$	67,500,000	
	48" Bore and Jack Pipeline & Casing		48		LF	$	2,496	$	-	
	48" HDD Pipeline		48	2,150	LF	$	1,344	$	2,900,000	
	48" Microtunnel Pipeline & Casing		48	-	LF	$	3,360	$	-	
	Sheeting and Shorting	7%	48	70,350	LF	$	67.20	$	4,700,000	
	Potholing (Heavy Urban)	2%	48	72,500	LF	$	19.20	$	1,400,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**118,000**	
Total No. Operators		-				
Average Annual Operator Hours per Year		hours	-			
Total Operator Hours per Year		hours	$0	$		
Annual Inspection and Pipeline Maintenance	72,500	LF	$1.63	$	118,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**118,000**	

Table 1-51. PL-12, 36-inch purified water pipeline from Sunnyvale AWPF to mid-point connecting to Joint Purified Water Pipeline (Portfolio 4)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	2/4/2020
				Project Number:	437-001-105
Aspect:	**PL-12. Purified water PL, Sunnyvale to Joint Purified Water PL**	**Diam**	**36 Inch**	Prepared By:	I Wald
		Length	**11,400 feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

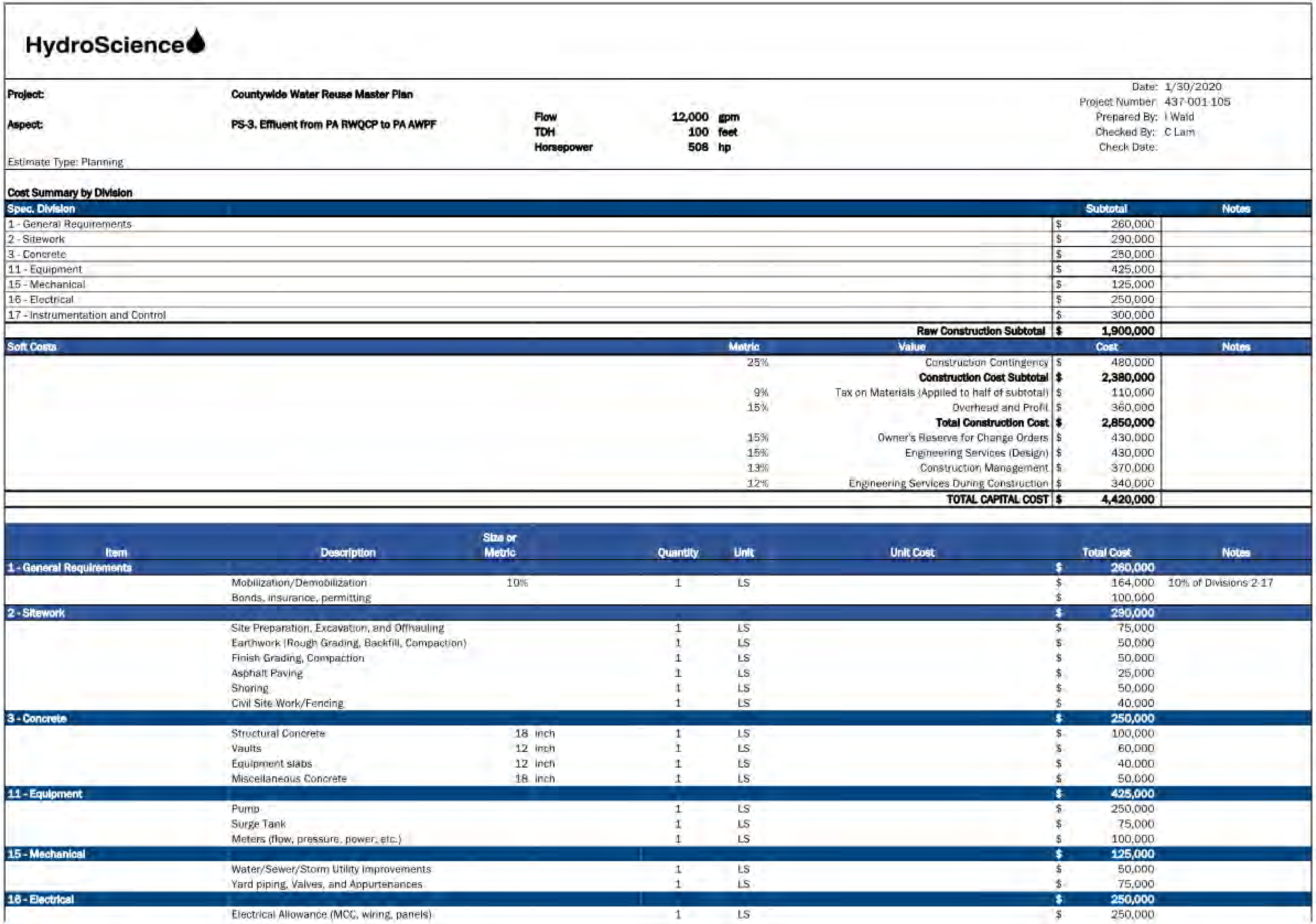
Spec. Division		Subtotal	Notes
1 - General Requirements		$ 600,000	
2 - Sitework		$ 9,200,000	
	Raw Construction Subtotal	**$ 9,800,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,450,000	
		Construction Cost Subtotal	**$ 12,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,800,000	
		Total Construction Cost	**$ 14,650,000**	
	15%	Owner's Reserve for Change Orders	$ 2,200,000	
	15%	Engineering Services (Design)	$ 2,200,000	
	13%	Construction Management	$ 1,900,000	
	12%	Engineering Services During Construction	$ 1,800,000	
		TOTAL CAPITAL COST	**$ 22,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 600,000**	
	Traffic Control (Heavy Urban)	7%	36	11,400	LS	$ 50.40	$ 600,000	7% of Divisions 2-17
2 - Sitework							**$ 9,200,000**	
	36" Open cut pipeline		36	10,550	LF	$ 720	$ 7,600,000	
	36" Bore and Jack Pipeline & Casing		36		LF	$ 1,872	$ -	
	36" HDD Pipeline		36	850	LF	$ 1,008	$ 900,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$ 2,520	$ -	
	Sheeting and Shorting	7%	36	10,550	LF	$ 50.40	$ 500,000	
	Potholing (Heavy Urban)	2%	36	11,400	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 19,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$ -	
Annual Inspection and Pipeline Maintenance	11,400	LF	$1.63	$ 19,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 19,000**	

Table 1-52. PS-3, pump station to convey Palo Alto RWQCP effluent to Palo Alto AWPF (Portfolio 4)



HydroScience

Project:	**Countywide Water Reuse Master Plan**				Date:	1/30/2020
					Project Number:	437-001-105
Aspect:	**PS-3. Effluent from PA RWQCP to PA AWPF**	**Flow**	**12,000**	**gpm**	Prepared By:	I Wald
		TDH	**100**	**feet**	Checked By:	C Lam
		Horsepower	**508**	**hp**	Check Date:	
Estimate Type: Planning						

Cost Summary by Division

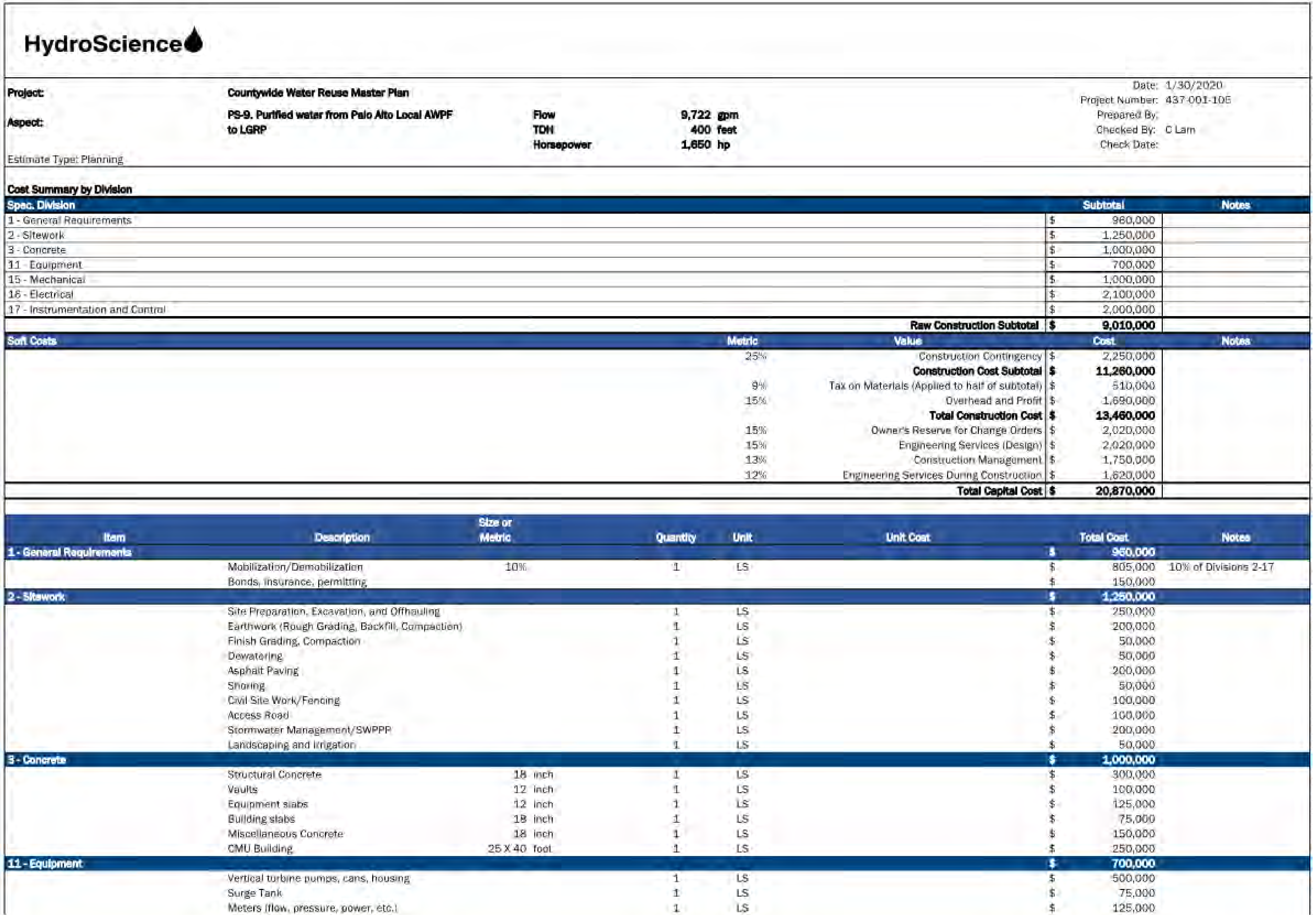
Spec. Division		**Subtotal**	**Notes**
1 - General Requirements	$	260,000	
2 - Sitework	$	290,000	
3 - Concrete	$	250,000	
11 - Equipment	$	425,000	
15 - Mechanical	$	125,000	
16 - Electrical	$	250,000	
17 - Instrumentation and Control	$	300,000	
Raw Construction Subtotal	**$**	**1,900,000**	

Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	480,000	
		Construction Cost Subtotal	**$**	**2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	110,000	
	15%	Overhead and Profit	$	360,000	
		Total Construction Cost	**$**	**2,850,000**	
	15%	Owner's Reserve for Change Orders	$	430,000	
	15%	Engineering Services (Design)	$	430,000	
	13%	Construction Management	$	370,000	
	12%	Engineering Services During Construction	$	340,000	
		TOTAL CAPITAL COST	**$**	**4,420,000**	

Item	**Description**	**Size or Metric**	**Quantity**	**Unit**	**Unit Cost**		**Total Cost**	**Notes**
1 - General Requirements						**$**	**260,000**	
	Mobilization/Demobilization	10%	1	LS		$	164,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	100,000	
2 - Sitework						**$**	**290,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	25,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	40,000	
3 - Concrete						**$**	**250,000**	
	Structural Concrete	18 inch	1	LS		$	100,000	
	Vaults	12 inch	1	LS		$	60,000	
	Equipment slabs	12 inch	1	LS		$	40,000	
	Miscellaneous Concrete	18 inch	1	LS		$	50,000	
11 - Equipment						**$**	**425,000**	
	Pump		1	LS		$	250,000	
	Surge Tank		1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	100,000	
15 - Mechanical						**$**	**125,000**	
	Water/Sewer/Storm Utility Improvements		1	LS		$	50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$	75,000	
16 - Electrical						**$**	**250,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$	250,000	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost	Total Cost	Notes
17 - I&C							**$ 300,000**	
	I&C/SCADA/Programming Allowance						$ 300,000	
ANNUAL O&M COSTS				**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables							**$ 22,000**	
	Equipment			2%		$425,000	$ 8,500	2% of Division 11
	Mechanical			2%		$125,000	$ 2,500	2% of Division 15
	Electrical			2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation			2%		$300,000	$ 6,000	2% of Division 17
Power Costs							**$ 332,000**	
	Electricity Requirement	508	hp	1,749,177	kWh	$0.19	$ 332,000	
						TOTAL ANNUAL O&M COSTS	**$ 354,000**	

Table 1-53. PS-9, pump station to convey Palo Alto AWPF purified water to LGRP (Portfolio 4)



HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	1/30/2020
				Project Number:	437-001-105
Aspect:	**PS-9. Purified water from Palo Alto Local AWPF to LGRP**	**Flow**	**9,722 gpm**	Prepared By:	
		TDH	**400 feet**	Checked By:	C Lam
		Horsepower	**1,650 hp**	Check Date:	
Estimate Type: Planning					

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	960,000	
2 - Sitework	$	1,250,000	
3 - Concrete	$	1,000,000	
11 - Equipment	$	700,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	2,100,000	
17 - Instrumentation and Control	$	2,000,000	
Raw Construction Subtotal	**$**	**9,010,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,250,000	
		Construction Cost Subtotal	**$**	**11,260,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	510,000	
	15%	Overhead and Profit	$	1,690,000	
		Total Construction Cost	**$**	**13,460,000**	
	15%	Owner's Reserve for Change Orders	$	2,020,000	
	15%	Engineering Services (Design)	$	2,020,000	
	13%	Construction Management	$	1,750,000	
	12%	Engineering Services During Construction	$	1,620,000	
		Total Capital Cost	**$**	**20,870,000**	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							**$**	**960,000**	
	Mobilization/Demobilization	10%		1	LS		$	805,000	10% of Divisions 2-17
	Bonds, insurance, permitting						$	150,000	
2 - Sitework							**$**	**1,250,000**	
	Site Preparation, Excavation, and Offhauling			1	LS		$	250,000	
	Earthwork (Rough Grading, Backfill, Compaction)			1	LS		$	200,000	
	Finish Grading, Compaction			1	LS		$	50,000	
	Dewatering			1	LS		$	50,000	
	Asphalt Paving			1	LS		$	200,000	
	Shoring			1	LS		$	50,000	
	Civil Site Work/Fencing			1	LS		$	100,000	
	Access Road			1	LS		$	100,000	
	Stormwater Management/SWPPP			1	LS		$	200,000	
	Landscaping and Irrigation			1	LS		$	50,000	
3 - Concrete							**$**	**1,000,000**	
	Structural Concrete	18	inch	1	LS		$	300,000	
	Vaults	12	inch	1	LS		$	100,000	
	Equipment slabs	12	inch	1	LS		$	125,000	
	Building slabs	18	inch	1	LS		$	75,000	
	Miscellaneous Concrete	18	inch	1	LS		$	150,000	
	CMU Building	25 X 40	foot	1	LS		$	250,000	
11 - Equipment							**$**	**700,000**	
	Vertical turbine pumps, cans, housing			1	LS		$	500,000	
	Surge Tank			1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)			1	LS		$	125,000	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost	Total Cost	Notes
15 - Mechanical							**$ 1,000,000**	
	Water/Sewer/Storm Utility improvements			1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances			1	LS		$ 800,000	
16 - Electrical							**$ 2,100,000**	
	Electrical Allowance (MCC, wiring, panels)			1	LS		$ 1,500,000	
	Standby generator			1	LS		$ 600,000	
17 - I&C							**$ 2,000,000**	
	I&C/SCADA/Programming Allowance						$ 2,000,000	
ANNUAL O&M COSTS				**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables							**$ 116,000**	
	Equipment			2%		$700,000	$ 14,000	2% of Division 11
	Mechanical			2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical			2%		$2,100,000	$ 42,000	2% of Division 16
	Instrumentation			2%		$2,000,000	$ 40,000	2% of Division 17
Power Costs							**$ 866,000**	
	Electricity Requirement	1,650	hp	5,414,877	kWh	$0.16	$ 866,000	
						TOTAL ANNUAL O&M COSTS	**$ 982,000**	

Table 1-54. PS-10, pump station to convey Sunnyvale AWPF purified water to LGRP (Portfolio 4)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	2/4/2020
Aspect:	**PS-10. Purified water from Sunnyvale AWPF to LGRP**	**Flow**	**6,945 gpm**	Project Number:	437-001-105
		TDH	**400 feet**	Prepared By:	
		Horsepower	**1,400 hp**	Checked By:	C Lam
Estimate Type: Planning				Check Date:	

Cost Summary by Division

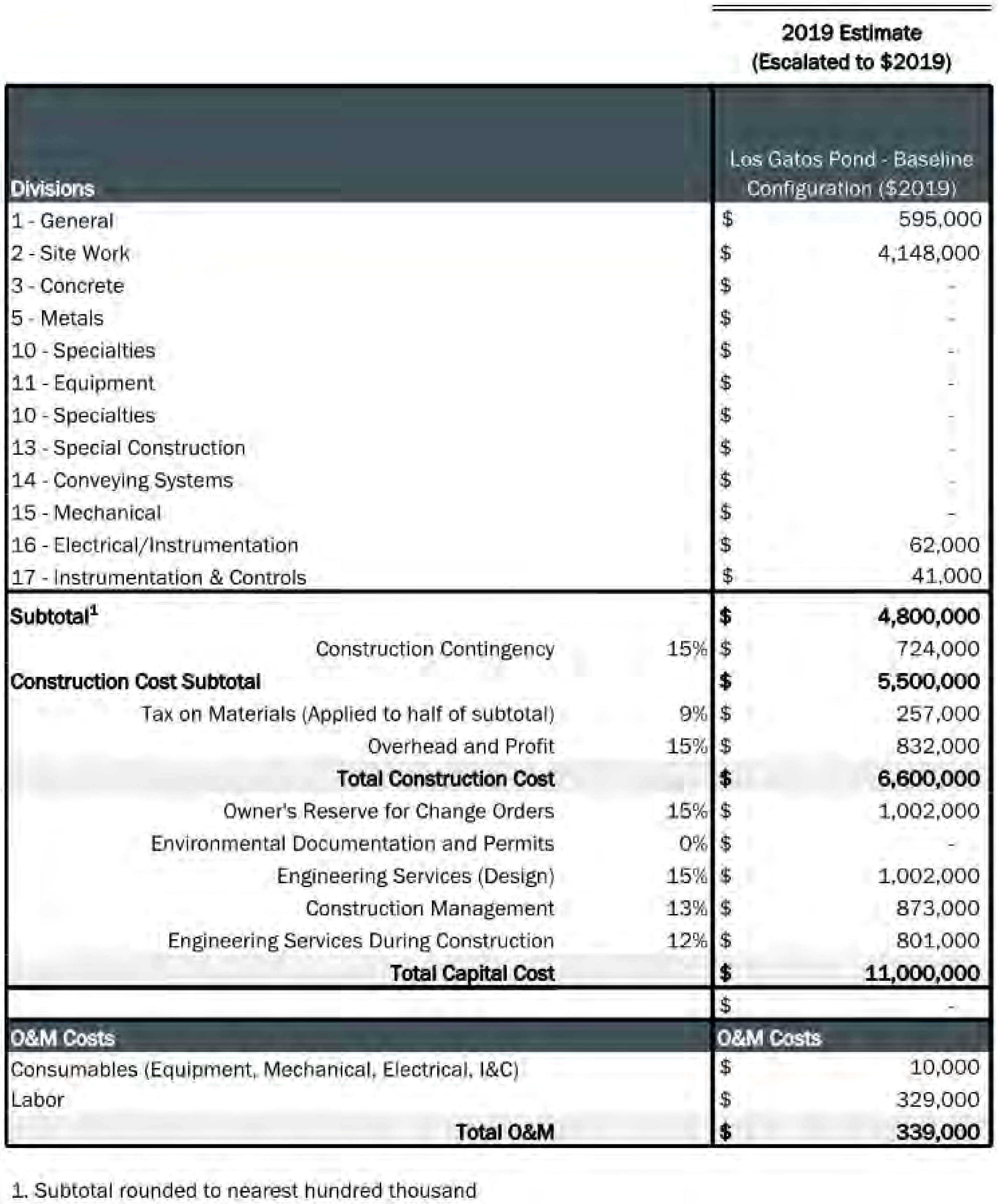
Spec. Division		**Subtotal**	**Notes**
1 - General Requirements	$	880,000	
2 - Sitework	$	1,250,000	
3 - Concrete	$	950,000	
11 - Equipment	$	650,000	
15 - Mechanical	$	800,000	
16 - Electrical	$	1,800,000	
17 - Instrumentation and Control	$	1,800,000	
Raw Construction Subtotal	**$**	**8,130,000**	

Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	2,030,000	
		Construction Cost Subtotal	**$**	**10,160,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	460,000	
	15%	Overhead and Profit	$	1,520,000	
		Total Construction Cost	**$**	**12,140,000**	
	15%	Owner's Reserve for Change Orders	$	1,820,000	
	15%	Engineering Services (Design)	$	1,820,000	
	13%	Construction Management	$	1,580,000	
	12%	Engineering Services During Construction	$	1,460,000	
		Total Capital Cost	**$**	**18,820,000**	

Item	**Description**	**Size or Metric**		**Quantity**	**Unit**	**Unit Cost**		**Total Cost**	**Notes**
1 - General Requirements							**$**	**880,000**	
	Mobilization/Demobilization	10%		1	LS		$	725,000	10% of Divisions 2-17
	Bonds, insurance, permitting						$	150,000	
2 - Sitework							**$**	**1,250,000**	
	Site Preparation, Excavation, and Offhauling			1	LS		$	250,000	
	Earthwork (Rough Grading, Backfill, Compaction)			1	LS		$	200,000	
	Finish Grading, Compaction			1	LS		$	50,000	
	Dewatering			1	LS		$	50,000	
	Asphalt Paving			1	LS		$	200,000	
	Shoring			1	LS		$	50,000	
	Civil Site Work/Fencing			1	LS		$	100,000	
	Access Road			1	LS		$	100,000	
	Stormwater Management/SWPPP			1	LS		$	200,000	
	Landscaping and Irrigation			1	LS		$	50,000	
3 - Concrete							**$**	**950,000**	
	Structural Concrete	18	inch	1	LS		$	300,000	
	Vaults	12	inch	1	LS		$	100,000	
	Equipment slabs	12	inch	1	LS		$	125,000	
	Building slabs	18	inch	1	LS		$	75,000	
	Miscellaneous Concrete	18	inch	1	LS		$	150,000	
	CMU Building	25 X 40	foot	1	LS		$	200,000	
11 - Equipment							**$**	**650,000**	
	Vertical turbine pumps, cans, housing			1	LS		$	450,000	
	Surge Tank			1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)			1	LS		$	125,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
15 - Mechanical						**$ 800,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 600,000	
16 - Electrical						**$ 1,800,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,300,000	
	Standby generator		1	LS		$ 500,000	
17 - I&C						**$ 1,800,000**	
	I&C/SCADA/Programming Allowance					$ 1,800,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 101,000**	
	Equipment		2%		$650,000	$ 13,000	2% of Division 11
	Mechanical		2%		$800,000	$ 16,000	2% of Division 15
	Electrical		2%		$1,800,000	$ 36,000	2% of Division 16
	Instrumentation		2%		$1,800,000	$ 36,000	2% of Division 17
Power Costs						**$ 774,000**	
	Electricity Requirement	1,400 hp	4,834,711	kWh	$0.16	$ 774,000	
					TOTAL ANNUAL O&M COSTS	**$ 875,000**	

Table 1-55. LGRP site improvements (Portfolio 4)



		2019 Estimate (Escalated to $2019)
Divisions		Los Gatos Pond - Baseline Configuration ($2019)
1 - General		$ 595,000
2 - Site Work		$ 4,148,000
3 - Concrete		$ -
5 - Metals		$ -
10 - Specialties		$ -
11 - Equipment		$ -
10 - Specialties		$ -
13 - Special Construction		$ -
14 - Conveying Systems		$ -
15 - Mechanical		$ -
16 - Electrical/Instrumentation		$ 62,000
17 - Instrumentation & Controls		$ 41,000
Subtotal[1]		**$ 4,800,000**
Construction Contingency	15%	$ 724,000
Construction Cost Subtotal		**$ 5,500,000**
Tax on Materials (Applied to half of subtotal)	9%	$ 257,000
Overhead and Profit	15%	$ 832,000
Total Construction Cost		**$ 6,600,000**
Owner's Reserve for Change Orders	15%	$ 1,002,000
Environmental Documentation and Permits	0%	$ -
Engineering Services (Design)	15%	$ 1,002,000
Construction Management	13%	$ 873,000
Engineering Services During Construction	12%	$ 801,000
Total Capital Cost		**$ 11,000,000**
		$ -
O&M Costs		**O&M Costs**
Consumables (Equipment, Mechanical, Electrical, I&C)		$ 10,000
Labor		$ 329,000
Total O&M		**$ 339,000**

1. Subtotal rounded to nearest hundred thousand

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 579,000	
2 - Sitework	$ 4,037,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 40,000	
Subtotal	$ 4,716,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost (2017 $)	Notes
1 - General Requirements							$ 579,000	
	Mobilization	10%		1	LS	$413,700	$ 414,000	10% of Divisions 2-17
	Traffic Control	4%		1	LS	$165,480	$ 165,000	Assumed average traffic control was light urban
2 - Sitework							$ 4,037,000	
	Page Pond Facilities							
	36", MLCSP, 12' Cover	36	in-dia	1,800	LF	$ 545	$ 980,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 49,000	$ 49,000	9' to 14' of cover
	Potholing			18	EA	$ 6,000	$ 108,000	Heavy Urban, $6,000 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
	Sunnyoaks Facilities							
	18", PVC, 8' Cover	18	in-dia	1,180	LF	$ 334	$ 394,000	100 ft/d production, Full lane AC, bell and spigot installation, 100% import
	Sheeting and Shoring (Open Cut)	3%		1	LS	$ 11,820	$ 12,000	Up to 8' of cover
	Potholing			12	EA	$ 3,600	$ 42,000	Light Urban, $3,600 per 100 feet of pipe

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

30", MLCSP, 12' Cover	30	in-dia	120	LF	$	430	$	52,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	2,600	$	3,000	9' to 14' of cover
Potholing			1	EA	$	6,000	$	7,000	Heavy Urban, $6,000 per 100 feet of pipe
18" BFV	18	in-dia	2	EA	$	8,579	$	17,000	Rs Means
12" Meter	12	in-dia	1	EA	$	15,000	$	15,000	Engineer's estimate
12" FCV	12	in-dia	1	EA	$	25,000	$	25,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	RS Means
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	LS	$	10,000	$	10,000	regrading, etc Engineer's estimate
Budd Ave Facilities									
24", MLCSP, 12' Cover	24	in-dia	1,630	LF	$	477	$	778,000	80 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	5%		1	LS	$	38,900	$	39,000	9' to 14' of cover
Potholing			16	EA	$	3,600	$	59,000	Light Urban, $3,600 per 100 feet of pipe
24" BFV	24	in-dia	2	EA	$	18,055	$	36,000	Rs Means
30" BFV	30	in-dia	2	EA	$	22,000	$	44,000	Engineer's estimate
18" Meter	18	in-dia	1	EA	$	20,000	$	20,000	Engineer's estimate
18" FCV	18	in-dia	1	EA	$	40,000	$	40,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	10,000	$	10,000	regrading, etc Engineer's estimate
Kirk Ditch Facilities									
36", MLCSP, 12' Cover	36	in-dia	40	Allow	$	545	$	22,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	1,100	$	1,000	9' to 14' of cover

RMC water and environment

Project: **SCVWD Purified Water Program Preliminary Engineering Services**

Aspect: **Los Gatos Pond - Baseline Configuration ($2017)**

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Estimate Type: Planning

Potholing			0	EA	$	1,200	$	-	Rural, $1,200 per 100 feet of pipe
36" BFV	36	in-dia	1	EA	$	25,000	$	25,000	Engineer's estimate
30" Meter	30	in-dia	1	EA	$	60,000	$	60,000	Engineer's estimate
30" FCV	30	in-dia	1	EA	$	80,000	$	80,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			114	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			13	CY	$	1,000	$	13,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			5	CY	$	800	$	4,000	RMC, 2017 (August 2017)
Rip Rap / Apron			20	CY	$	133	$	3,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	25,000	$	25,000	regrading, etc Engineer's estimate
16 - Electrical							**$**	**60,000**	
Electrical Allowance			4	EA		$15,000	$	60,000	Engineers Estimate
17 - I&C							**$**	**40,000**	
I&C Allowance			4	EA		$10,000	$	40,000	Engineers Estimate

ANNUAL O&M COSTS	**Quantity**	**Unit**	**Value**		**Cost**	**Notes**
Consumables				**$**	**10,000**	
Mechanical	2%		$487,000	$	10,000	2% of Valves and Meters
Labor Costs				**$**	**315,000**	
Pond Maintenance	68	AC	$4,531	$	307,000	Engineer's estimate
Annual Inspection and Maintenance of Pipeline - Average Annual Operator Hours per Year	47	HR	$175	$	8,000	Engineer's estimate

Morgan Hill options cost estimate details

Table 1-56. PL-35, 16-inch NPR+ pipeline from Metcalf Energy Center to Burnett Road at Monterey (Morgan Hill Option 1)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	10/22/2019
				Project Number:	437-001-105
Aspect:	**PL-35: Metcalf to Burnett**	**Diam**	**16 inch**	Prepared By:	I Wald
		Length	**31,500 feet**	Checked By:	C Lam
				Check Date:	

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 710,000	
2 - Sitework		$ 11,050,000	
	Raw Construction Subtotal	**$ 12,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,000,000	
		Construction Cost Subtotal	**$ 15,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 680,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,250,000	
		Total Construction Cost	**$ 17,930,000**	
	15%	Owner's Reserve for Change Orders	$ 2,690,000	
	15%	Engineering Services (Design)	$ 2,690,000	
	13%	Construction Management	$ 2,330,000	
	12%	Engineering Services During Construction	$ 2,150,000	
		Total Capital Cost	**$ 28,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 710,000**	
	Traffic Control (Heavy Urban)	7%	16	31,500	LS	$ 22.40	$ 710,000	7% of Divisions 2-17
2 - Sitework							**$ 11,050,000**	
	16" Open cut pipeline		16	31,350	LF	$ 320	$ 10,030,000	
	16" Bore and Jack Pipeline & Casing		16	150	LF	$ 832	$ 120,000	
	16" HDD Pipeline		16	-	LF	$ 448	$ -	
	16" Microtunnel Pipeline & Casing		16	-	LF	$ 1,120	$ -	
	Sheeting and Shorting	7%	16	31,350	LF	$ 22.40	$ 700,000	
	Potholing (Heavy Urban)	2%	16	31,350	LF	$ 6.40	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 51,408**	
Annual Inspection and Pipeline Maintenance	31,500	LF	$1.63	$ 51,408	
			TOTAL ANNUAL O&M COSTS	**$ 51,000**	

Table 1-57. Satellite WWTP and AWPF, 2.5 mgd for GWR (Morgan Hill Option 2)

Focus: **Cost Summary**
Element: **Morgan Hill Satellite WWTP and AWPF**
Capacity: **2.5 mgd**
Location: **Morgan Hill**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	24,000,000
Contingency - Treatment Facility	25%	$	6,000,000
Construction Cost Subtotal		$	30,000,000
Tax on Materials (applied to half of subtotal)	9%	$	2,000,000
General Contractor Overhead and Profit	15%	$	5,000,000
Estimated Total Construction Cost		**$**	**37,000,000**
Owner's Reserve for Change Orders	15%	$	6,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	6,000,000
Construction Management	13%	$	5,000,000
Engineering Services During Construction	12%	$	5,000,000
Total Capital Cost		**$**	**59,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	710,000
Energy/Power	$	1,020,000
Chemicals	$	2,890,000
Labor	$	2,080,000
Total Annual O&M Cost	**$**	**6,700,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	35,000,000
30-yr Lifecycle (present value, $2019)	$	16,000,000

*See Attachment C, Basis of Cost for explanation of methodology

Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	3,010,000
Annual O&M Cost		$	6,700,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	530,000
Total Annual Cost		**$**	**10,240,000**
Annual Yield	AF		**2,350**
Unit Cost ($/AF)		**$**	**4,360**

Costs by Division		**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$	2,142,700	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	1,886,800	8%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	200,000	1%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	250,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	804,300	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	3,217,000	13%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	1,025,500	4%
Division 32 – Exterior Improvements	$	70,700	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	3,124,700	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	1,790,700	7%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	9,056,600	38%
TOTAL	**$**	**24,000,000**	

Focus: **Cost Inputs and R&R**
Element: **Morgan Hill Satellite WWTP and AWPF**
Capacity: **2.5 mgd**
Location: **Morgan Hill**

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B Adjusted Unit	Cost Method C Project-Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Headworks Slab		144	CY		$ 645		Slab 65'x35',10" thick	$ 92,900	
Division 03 – Concrete	Concrete	Valve Vault Slab		10	CY		$ 645		Slab 13' x 12' x 2' thick	$ 6,300	Diversion Wetwell & Pump Station
Division 03 – Concrete	Concrete	Valve Vault Walls		13	CY		$ 1,090		Walls 5' high, 8" thick	$ 14,000	Diversion Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Slab		14	CY		$ 645		Slab 16' x 12' x 2' thick	$ 9,200	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		31	CY		$ 1,090		Walls 10' high, 8" thick	$ 34,000	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	EQ Basin Slab		197	CY		$ 645		Slab 31' x 86' x 2' thick	$ 127,400	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		74	CY		$ 1,150		Suspended Slab 25' x 80' x 1' thick	$ 85,200	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		312	CY		$ 1,090		Walls 24' depth, 8" thick	$ 340,100	EQ Basin
Division 03 – Concrete	Concrete	MBR Walls		41	CY		$ 645		Walls 4.7' high, 8" thick	$ 26,800	Treatment Equipment
Division 03 – Concrete	Concrete	MBR Blowers Slab Area		124	CY		$ 1,090		Slab 12' x 60' x 2' thick	$ 135,700	Treatment Equipment
Division 03 – Concrete	Concrete	MBR Membrane Slab Area		557	CY		$ 645		Slab area = 3500 ft ^2	$ 359,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		68	CY		$ 645		Slab 23' x 10' x 2' thick	$ 44,000	Treatment Equipment
Division 03 – Concrete	Concrete	RO CIP Area Slab		43	CY		$ 645		Slab 24' x 24' x 2' thick	$ 27,600	Treatment Equipment
Division 03 – Concrete	Concrete	RO CIP Area Walls		11	CY		$ 1,090		Walls 24' high, 8" thick	$ 12,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		19	CY		$ 645		Slab 10' x 25' x 2' thick	$ 12,000	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		44	CY		$ 645		Slab 20' x 30' x 2' thick	$ 28,700	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		123	CY		$ 645		Slabs areas = 1658 ft^2, 2' thick	$ 79,300	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		27	CY		$ 1,090		Walls 4.7' high, 8" thick	$ 28,900	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		555	CY		$ 645		Slab 70' x 107', 2' thick	$ 358,000	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		18	CY		$ 645		Slab 20' x 12', 2' thick	$ 11,500	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		17	CY		$ 645		Slab 15' x 15', 2' thick	$ 10,800	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Manhole		1	CY		$ 21,430		5' diam, 8' deep	$ 21,500	
Division 03 – Concrete	Concrete	RO Waste Equalization Wetwell Manhole		1	CY		$ 21,430		5' diam, 8' deep	$ 21,500	
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		1,334	LF		$ 52.94			$ 70,700	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 200,000	Engineer's Estimate	$ 200,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 250,000	Engineer's Estimate	$ 250,000	for 24 MGD facility

Focus: **Cost Inputs and R&R**
Element: **Morgan Hill Satellite WWTP and AWPF**
Capacity: **2.5 mgd**
Location: **Morgan Hill**

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	MBR System		1	LS	$ 3,028,125			Proposal for a 2 MGD system, includes: MBR,RAS Pumps, Filtrate and Air Headers,Filtrate Pumping System, Chemical System, Blowers, Air system, Manufacturing services, plus 25% to account for extra 0.5 mgd	$ 3,028,200	
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	6,000	1				$ 42,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 42,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	2	2	EA			$ 7,500		$ 15,000	Cost from Des
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 3,441,464			Revised 9/22/17 Proposal from Wigen includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 3,441,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA			$ 50,000	Estimated based on costs from Des	$ 200,000	
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 375,000			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 375,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 3,000				$ 12,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 1,345,500			Based on packaged quote from Wedeco. See notes for what this package assumes	$ 1,345,500	Package includes reactors, instrumentation control automation,ballasts, instrumentation, chemical feed/static mixing system, field services(does not include installation so used this quote)

Table 1-58. PS-13, pump station to convey Morgan Hill AWPF purified water to San Pedro Recharge Ponds (Morgan Hill Option 2)

HydroScience

Project:	**Countywide Water Reuse Master Plan**		
Aspect:	**PS 13 - Morgan Hill AWPF to San Pedro Ponds**	**Flow**	**1,458 gpm**
		TDH	**125 feet**
		Horsepower	**78 hp**

Date: 10/15/2019
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam
Check Date:

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 60,000	
2 - Sitework	$ 110,000	
3 - Concrete	$ 80,000	
11 - Equipment	$ 65,000	
15 - Mechanical	$ 25,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 60,000	
Raw Construction Subtotal	**$ 460,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 115,000	
		Construction Cost Subtotal	**$ 575,000**	
	15%	Overhead and Profit	$ 100,000	
		Total Construction Cost	**$ 675,000**	
	15%	Owner's Reserve for Change Orders	$ 100,000	
	15%	Engineering Services (Design)	$ 100,000	
	13%	Construction Management	$ 100,000	
	12%	Engineering Services During Construction	$ 100,000	
		Total Capital Cost	**$ 1,075,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 60,000**	
	Mobilization/Demobilization	10%	1	LS		$ 40,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 20,000	
2 - Sitework						**$ 110,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 15,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 25,000	
	Finish Grading, Compaction		1	LS		$ 15,000	
	Asphalt Paving		1	LS		$ 10,000	
	Shoring		1	LS		$ 10,000	
	Civil Site Work/Fencing		1	LS		$ 10,000	
	Access Road		1	LS		$ 10,000	
	Landscaping and irrigation		1	LS		$ 15,000	
3 - Concrete						**$ 80,000**	
	Structural Concrete	18 inch	1	LS		$ 40,000	
	Vaults	12 inch	1	LS		$ 20,000	
	Equipment slabs	12 inch	1	LS		$ 20,000	

11 - Equipment						**$ 65,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 50,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 15,000	
15 - Mechanical						**$ 25,000**	
	Yard piping, Valves, and Appurtenances		1	LS		$ 25,000	
16 - Electrical						**$ 60,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 60,000	
	Standby generator		1	LS			Power from AWTF
17 - I&C						**$ 60,000**	
	I&C/SCADA/Programming Allowance					$ 60,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 4,200**	
	Equipment		2%		$65,000	$ 1,300	2% of Division 11
	Mechanical		2%		$25,000	$ 500	2% of Division 15
	Electrical		2%		$60,000	$ 1,200	2% of Division 16
	Instrumentation		2%		$60,000	$ 1,200	2% of Division 17
Power Costs						**$ 40,977**	
	Electricity Requirement	78 HP	256,107	kWh	$0.16	$ 40,977	
					TOTAL ANNUAL O&M COSTS	**$ 45,177**	

Table 1-59. PL-25, 16-inch purified water pipeline from Morgan Hill AWPF to San Pedro Recharge Ponds (Morgan Hill Option 2)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 2/10/2020
				Project Number: 437-001-105
Aspect:	**PL-25: Morgan Hill AWPF to San Pedro**	**Diam**	**16 inch**	Prepared By: I Wald
		Length	**14,600 feet**	Checked By: C Lam
				Check Date:

Estimate Type: Planning

Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 330,000	
2 - Sitework			$ 5,340,000	
		Raw Construction Subtotal	**$ 5,700,000**	
Soft Costs	**Metric**	**Value**	**Cost**	**Notes**
	25%	Construction Contingency	$ 1,425,000	
		Construction Cost Subtotal	**$ 7,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 320,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,070,000	
		Total Construction Cost	**$ 8,515,000**	
	15%	Owner's Reserve for Change Orders	$ 1,280,000	
	15%	Engineering Services (Design)	$ 1,280,000	
	13%	Construction Management	$ 1,110,000	
	12%	Engineering Services During Construction	$ 1,020,000	
		Total Capital Cost	**$ 13,200,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 330,000**	
	Traffic Control (Heavy Urban)	7%	16	14,600	LS	$ 22.40	$ 330,000	7% of Divisions 2-17
2 - Sitework							**$ 5,340,000**	
	16" Open cut pipeline		16	14,100	LF	$ 320	$ 4,510,000	
	16" Bore and Jack Pipeline & Casing		16	500	LF	$ 832	$ 420,000	
	16" HDD Pipeline		16	-	LF	$ 448	$ -	
	16" Microtunnel Pipeline & Casing		16	-	LF	$ 1,120	$ -	
	Sheeting and Shorting	7%	16	14,100	LF	$ 22.40	$ 320,000	
	Potholing (Heavy Urban)	2%	16	14,100	LF	$ 6.40	$ 90,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 23,827**	
Annual Inspection and Pipeline Maintenance	14,600	LF	$1.63	$ 23,827	
			TOTAL ANNUAL O&M COSTS	**$ 24,000**	

Table 1-60. Satellite WWTP and AWPF, 2.5 mgd for GWR (Morgan Hill Option 3)

Focus: **Cost Summary**
Element: **Morgan Hill Satellite WWTP and AWPF**
Capacity: **2.5 mgd**
Location: **Morgan Hill**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	24,000,000
Contingency - Treatment Facility	25%	$	6,000,000
Construction Cost Subtotal		$	30,000,000
Tax on Materials (applied to half of subtotal)	9%	$	2,000,000
General Contractor Overhead and Profit	15%	$	5,000,000
Estimated Total Construction Cost		**$**	**37,000,000**
Owner's Reserve for Change Orders	15%	$	6,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	6,000,000
Construction Management	13%	$	5,000,000
Engineering Services During Construction	12%	$	5,000,000
Total Capital Cost		**$**	**59,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	710,000
Energy/Power	$	1,020,000
Chemicals	$	2,890,000
Labor	$	2,080,000
Total Annual O&M Cost	**$**	**6,700,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	35,000,000
30-yr Lifecycle (present value, $2019)	$	16,000,000

*See Attachment C, Basis of Cost for explanation of methodology

Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	3,010,000
Annual O&M Cost		$	6,700,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	530,000
Total Annual Cost		**$**	**10,240,000**
Annual Yield	AF		**2,350**
Unit Cost ($/AF)		**$**	**4,360**

Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	2,142,700	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	1,886,800	8%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	200,000	1%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	250,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	804,300	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	3,217,000	13%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	1,025,500	4%
Division 32 – Exterior Improvements	$	70,700	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	3,124,700	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	1,790,700	7%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	9,056,600	38%
TOTAL	**$**	**24,000,000**	

Focus: **Cost Inputs and R&R**
Element: **Morgan Hill Satellite WWTP and AWPF**
Capacity: **2.5 mgd**
Location: **Morgan Hill**

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B Adjusted Unit	Cost Method C Project-Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Headworks Slab		144	CY		$ 645		Slab 65'x35',10" thick	$ 92,900	
Division 03 – Concrete	Concrete	Valve Vault Slab		10	CY		$ 645		Slab 13' x 12' x 2' thick	$ 6,300	Diversion Wetwell & Pump Station
Division 03 – Concrete	Concrete	Valve Vault Walls		13	CY		$ 1,090		Walls 5' high, 8" thick	$ 14,000	Diversion Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Slab		14	CY		$ 645		Slab 16' x 12' x 2' thick	$ 9,200	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		31	CY		$ 1,090		Walls 10' high, 8" thick	$ 34,000	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	EQ Basin Slab		197	CY		$ 645		Slab 31' x 86' x 2' thick	$ 127,400	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		74	CY		$ 1,150		Suspended Slab 25' x 80' x 1' thick	$ 85,200	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		312	CY		$ 1,090		Walls 24' depth, 8" thick	$ 340,100	EQ Basin
Division 03 – Concrete	Concrete	MBR Walls		41	CY		$ 645		Walls 4.7' high, 8" thick	$ 26,800	Treatment Equipment
Division 03 – Concrete	Concrete	MBR Blowers Slab Area		124	CY		$ 1,090		Slab 12' x 60' x 2' thick	$ 135,700	Treatment Equipment
Division 03 – Concrete	Concrete	MBR Membrane Slab Area		557	CY		$ 645		Slab area = 3500 ft ^2	$ 359,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		68	CY		$ 645		Slab 23' x 10' x 2' thick	$ 44,000	Treatment Equipment
Division 03 – Concrete	Concrete	RO CIP Area Slab		43	CY		$ 645		Slab 24' x 24' x 2' thick	$ 27,600	Treatment Equipment
Division 03 – Concrete	Concrete	RO CIP Area Walls		11	CY		$ 1,090		Walls 24' high, 8" thick	$ 12,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		19	CY		$ 645		Slab 10' x 25' x 2' thick	$ 12,000	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		44	CY		$ 645		Slab 20' x 30' x 2' thick	$ 28,700	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		123	CY		$ 645		Slabs areas = 1658 ft^2, 2' thick	$ 79,300	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		27	CY		$ 1,090		Walls 4.7' high, 8" thick	$ 28,900	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		555	CY		$ 645		Slab 70' x 107', 2' thick	$ 358,000	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		18	CY		$ 645		Slab 20' x 12', 2' thick	$ 11,500	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		17	CY		$ 645		Slab 15' x 15', 2' thick	$ 10,800	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Manhole		1	CY		$ 21,430		5' diam, 8' deep	$ 21,500	
Division 03 – Concrete	Concrete	RO Waste Equalization Wetwell Manhole		1	CY		$ 21,430		5' diam, 8' deep	$ 21,500	
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		1,334	LF		$ 52.94			$ 70,700	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 200,000	Engineer's Estimate	$ 200,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 250,000	Engineer's Estimate	$ 250,000	for 24 MGD facility

Brown AND Caldwell

Focus: **Cost Inputs and R&R**
Element: **Morgan Hill Satellite WWTP and AWPF**
Capacity: **2.5 mgd**
Location: **Morgan Hill**

Date:	2/10/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Prepared by:	M. Tsuruda
Checked By:	D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	MBR System		1	LS	$ 3,028,125			Proposal for a 2 MGD system, includes: MBR,RAS Pumps, Filtrate and Air Headers,Filtrate Pumping System, Chemical System, Blowers, Air system, Manufacturing services, plus 25% to account for extra 0.5 mgd	$ 3,028,200	
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	6,000	1				$ 42,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 42,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	2	2	EA			$ 7,500		$ 15,000	Cost from Des
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 3,441,464			Revised 9/22/17 Proposal from Wigen includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 3,441,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA			$ 50,000	Estimated based on costs from Des	$ 200,000	
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 375,000			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 375,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 3,000				$ 12,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 1,345,500			Based on packaged quote from Wedeco. See notes for what this package assumes	$ 1,345,500	Package includes reactors, instrumentation control automation,ballasts, instrumentation, chemical feed/static mixing system, field services(does not include installation so used this quote)

Table 1-61. PS-11, pump station to convey Morgan Hill AWPF purified water to the booster pump station (Morgan Hill Option 3)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	10/15/2019
				Project Number:	437-001-105
		Flow	**1,458 gpm**	Prepared By:	I Wald
Aspect:	**PS 11 - Morgan Hill AWPF to BPS**	**TDH**	**500 feet**	Checked By:	C Lam
		Horsepow	**279 hp**	Check Date:	

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 140,000	
2 - Sitework	$ 230,000	
3 - Concrete	$ 150,000	
11 - Equipment	$ 200,000	
15 - Mechanical	$ 100,000	
16 - Electrical	$ 150,000	
17 - Instrumentation and Control	$ 150,000	
Raw Construction Subtotal	**$ 1,100,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 275,000	
		Construction Cost Subtotal	**$ 1,375,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 100,000	
	15%	Overhead and Profit	$ 200,000	
		Total Construction Cost	**$ 1,675,000**	
	15%	Owner's Reserve for Change Orders	$ 300,000	
	15%	Engineering Services (Design)	$ 300,000	
	13%	Construction Management	$ 200,000	
	12%	Engineering Services During Construction	$ 200,000	
		Total Capital Cost	**$ 3,000,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 140,000**	
	Mobilization/Demobilization	10%	1	LS		$ 98,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 40,000	
2 - Sitework						**$ 230,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 20,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 50,000	
	Finish Grading, Compaction		1	LS		$ 20,000	
	Dewatering		1	LS		$ 20,000	
	Asphalt Paving		1	LS		$ 25,000	
	Shoring		1	LS		$ 20,000	
	Civil Site Work/Fencing		1	LS		$ 20,000	
	Access Road		1	LS		$ 20,000	
	Stormwater Management/SWPPP		1	LS		$ 20,000	
	Landscaping and irrigation		1	LS		$ 15,000	

3 - Concrete						**$**	**150,000**	
	Structural Concrete	18 inch	1	LS		$	100,000	
	Vaults	12 inch	1	LS		$	25,000	
	Equipment slabs	12 inch	1	LS		$	25,000	
11 - Equipment						**$**	**200,000**	
	Vertical turbine pumps, cans, housing		1	LS		$	130,000	
	Surge Tank		1	LS		$	20,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	50,000	
15 - Mechanical						**$**	**100,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$	50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$	50,000	
16 - Electrical						**$**	**150,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$	150,000	
	Standby generator		1	LS				Power from AWTF
17 - I&C						**$**	**150,000**	
	I&C/SCADA/Programming Allowance					$	150,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**		**Cost**	**Notes**
Consumables						**$**	**12,000**	
	Equipment		2%		$200,000	$	4,000	2% of Division 11
	Mechanical		2%		$100,000	$	2,000	2% of Division 15
	Electrical		2%		$150,000	$	3,000	2% of Division 16
	Instrumentation		2%		$150,000	$	3,000	2% of Division 17
Power Costs						**$**	**334,392**	
	Electricity Requirement	279 HP	2,089,947	kWh	$0.16	$	334,392	
					TOTAL ANNUAL O&M COSTS	**$**	**346,000**	

Table 1-62. PS-12, pump station to convey purified water from the booster pump station to Anderson Reservoir (Morgan Hill Option 3)

HydroScience

				Date:	10/15/2019
Project:	**Countywide Water Reuse Master Plan**			Project Number:	437-001-105
Aspect:	**PS 12 - BPS to Anderson Reservoir (Morgan Hill)**	**Flow**	**1,458 gpm**	Prepared By:	I Wald
		TDH	**350 feet**	Checked By:	C Lam
		Horsepower	**218 hp**	Check Date:	
Estimate Type: Planning					

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 100,000	
2 - Sitework	$ 200,000	
3 - Concrete	$ 100,000	
11 - Equipment	$ 70,000	
15 - Mechanical	$ 30,000	
16 - Electrical	$ 250,000	
17 - Instrumentation and Control	$ 150,000	
Raw Construction Subtotal	**$ 900,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 225,000	
		Construction Cost Subtotal	**$ 1,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 100,000	
	15%	Overhead and Profit	$ 200,000	
		Total Construction Cost	**$ 1,425,000**	
	15%	Owner's Reserve for Change Orders	$ 200,000	
	15%	Engineering Services (Design)	$ 200,000	
	13%	Construction Management	$ 200,000	
	12%	Engineering Services During Construction	$ 200,000	
		Total Capital Cost	**$ 2,000,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 100,000**	
	Mobilization/Demobilization	10%	1	LS		$ 80,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 25,000	
2 - Sitework						**$ 200,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 20,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 50,000	
	Finish Grading, Compaction		1	LS		$ 20,000	
	Asphalt Paving		1	LS		$ 15,000	
	Shoring		1	LS		$ 20,000	
	Civil Site Work/Fencing		1	LS		$ 20,000	
	Access Road		1	LS		$ 10,000	
	Landscaping and irrigation		1	LS		$ 15,000	

3 - Concrete						**$**	**100,000**	
	Structural Concrete	18 inch	1	LS		$	40,000	
	Vaults	12 inch	1	LS		$	25,000	
	Equipment slabs	12 inch	1	LS		$	25,000	
11 - Equipment						**$**	**70,000**	
	Vertical turbine pumps, cans, housing		1	LS		$	10,000	
	Surge Tank		1	LS		$	20,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	40,000	
15 - Mechanical						**$**	**30,000**	
	Yard piping, Valves, and Appurtenances		1	LS		$	30,000	
16 - Electrical						**$**	**250,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$	150,000	
	Standby generator		1	LS		$	100,000	
17 - I&C						**$**	**150,000**	
	I&C/SCADA/Programming Allowance					$	150,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**		**Cost**	**Notes**
Consumables						**$**	**10,000**	
	Equipment		2%		$70,000	$	1,400	2% of Division 11
	Mechanical		2%		$30,000	$	600	2% of Division 15
	Electrical		2%		$250,000	$	5,000	2% of Division 16
	Instrumentation		2%		$150,000	$	3,000	2% of Division 17
Power Costs						**$**	**114,736**	
	Electricity Requirement	218 HP	717,099	kWh	$0.16	$	114,736	
					TOTAL ANNUAL O&M COSTS	**$**	**124,736**	

Table 1-63. PL-26, 16-inch purified water pipeline from Morgan Hill AWPF to Anderson Reservoir (Morgan Hill Option 3)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	2/10/2020
				Project Number:	437-001-105
Aspect:	**PL-26: Morgan Hill AWPF to Anderson Reservoir**	**Diam**	**16 inch**	Prepared By:	I Wald
		Length	**29,400 feet**	Checked By:	C Lam
				Check Date:	

Estimate Type: Planning

Cost Summary by Division

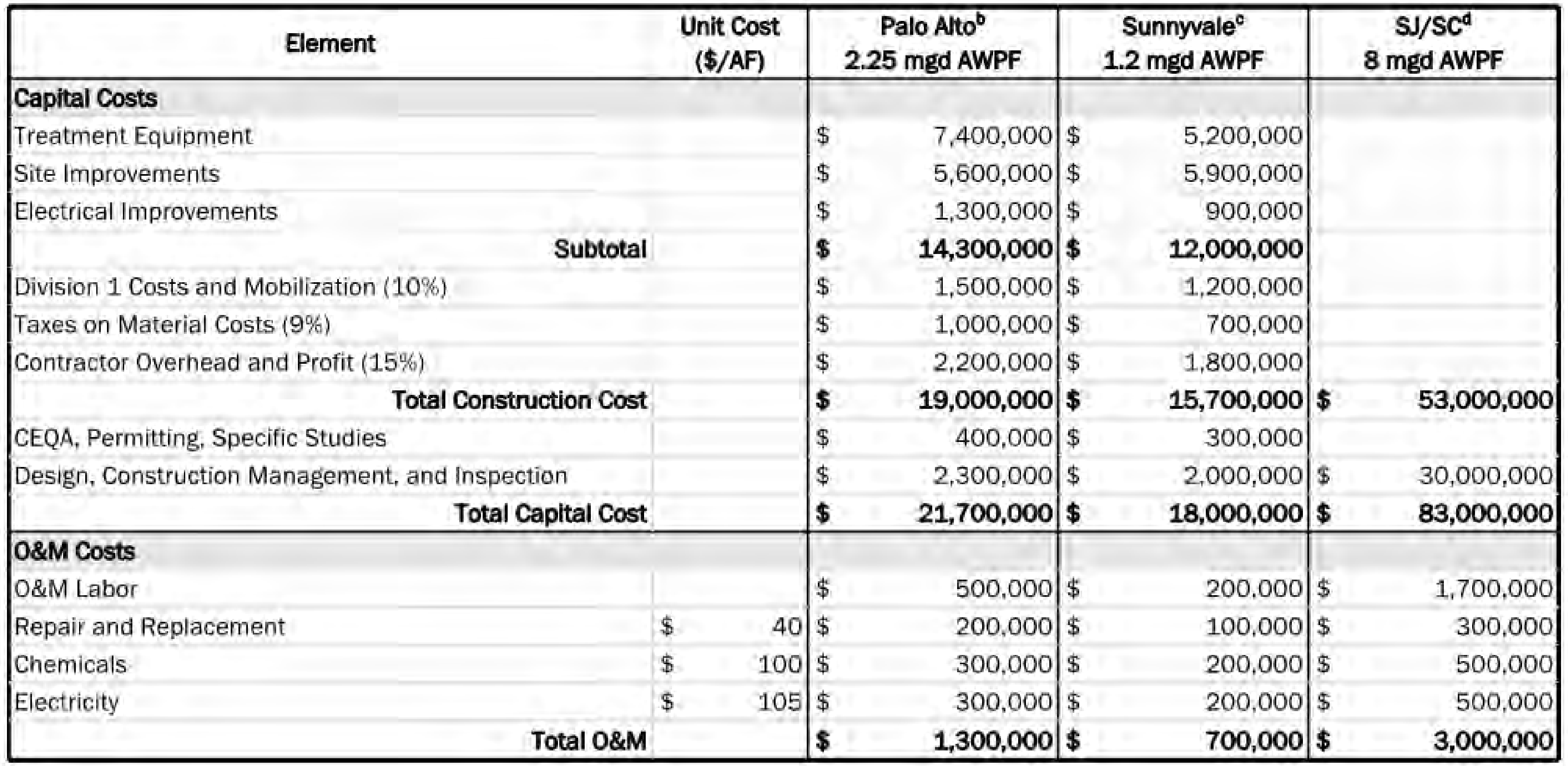
Spec. Division			Subtotal	Notes
1 - General Requirements			$ 660,000	
2 - Sitework			$ 10,500,000	
		Raw Construction Subtotal	**$ 11,200,000**	
Soft Costs	**Metric**	**Value**	**Cost**	**Notes**
	25%	Construction Contingency	$ 2,800,000	
		Construction Cost Subtotal	**$ 14,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 630,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,100,000	
		Total Construction Cost	**$ 16,730,000**	
	15%	Owner's Reserve for Change Orders	$ 2,510,000	
	15%	Engineering Services (Design)	$ 2,510,000	
	13%	Construction Management	$ 2,170,000	
	12%	Engineering Services During Construction	$ 2,010,000	
		Total Capital Cost	**$ 25,900,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 660,000**	
	Traffic Control (Heavy Urban)	7%	16	29,400	LS	$ 22.40	$ 660,000	7% of Divisions 2-17
2 - Sitework							**$ 10,500,000**	
	16" Open cut pipeline		16	28,900	LF	$ 320	$ 9,250,000	
	16" Bore and Jack Pipeline & Casing		16	500	LF	$ 832	$ 420,000	
	16" HDD Pipeline		16	-	LF	$ 448	$ -	
	16" Microtunnel Pipeline & Casing		16	-	LF	$ 1,120	$ -	
	Sheeting and Shorting	7%	16	28,900	LF	$ 22.40	$ 650,000	
	Potholing (Heavy Urban)	2%	16	28,900	LF	$ 6.40	$ 180,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 47,981**	
Annual Inspection and Pipeline Maintenance	29,400	LF	$1.63	$ 47,981	
			TOTAL ANNUAL O&M COSTS	**$ 48,000**	

Future opportunities and alternative elements cost estimate details

Table 1-64. NPR+ AWPFs a



Element	Unit Cost ($/AF)	Palo Alto[b] 2.25 mgd AWPF	Sunnyvale[c] 1.2 mgd AWPF	SJ/SC[d] 8 mgd AWPF
Capital Costs				
Treatment Equipment		$ 7,400,000	$ 5,200,000	
Site Improvements		$ 5,600,000	$ 5,900,000	
Electrical Improvements		$ 1,300,000	$ 900,000	
Subtotal		**$ 14,300,000**	**$ 12,000,000**	
Division 1 Costs and Mobilization (10%)		$ 1,500,000	$ 1,200,000	
Taxes on Material Costs (9%)		$ 1,000,000	$ 700,000	
Contractor Overhead and Profit (15%)		$ 2,200,000	$ 1,800,000	
Total Construction Cost		**$ 19,000,000**	**$ 15,700,000**	**$ 53,000,000**
CEQA, Permitting, Specific Studies		$ 400,000	$ 300,000	
Design, Construction Management, and Inspection		$ 2,300,000	$ 2,000,000	$ 30,000,000
Total Capital Cost		**$ 21,700,000**	**$ 18,000,000**	**$ 83,000,000**
O&M Costs				
O&M Labor		$ 500,000	$ 200,000	$ 1,700,000
Repair and Replacement	$ 40	$ 200,000	$ 100,000	$ 300,000
Chemicals	$ 100	$ 300,000	$ 200,000	$ 500,000
Electricity	$ 105	$ 300,000	$ 200,000	$ 500,000
Total O&M		**$ 1,300,000**	**$ 700,000**	**$ 3,000,000**

a. Costs shown in 2019 dollars and rounded up to the nearest 100,000 value.

b. Based on cost for 2.25-mgd facility in Advanced Water Purification System Preliminary/Conceptual Design Report, December 2017.

c. Cost for Sunnyvale 1.2-mgd facility estimated by scaling down the Palo Alto facility's estimated costs.

d. Cost for SJ/SC 8-mgd facility estimated based on 2011 SVAWPC construction cost from schedule of values and July 2018-June 2019 actual O&M costs.

Table 1-65. Purified water pipeline extension from LGRP to Rinconada WTP for RWA (Portfolios 1a, 2a, 2b, and/or 4)

HydroScience

Project: **Countywide Water Reuse Master Plan**
Aspect: **Purified Water Pipeline**
Location: **LGRP to Rinconada WTP**
Estimate Type: Planning

Diam **30 inch**
Length **12,400 feet**

Date: 10/8/2019
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	500,000	
2 - Sitework	$	8,200,000	
3 - Concrete	$	-	
4 - Masonry			
5 - Metals	$	-	
6 - Wood and Plastic	$	-	
7 - Moisture and Thermal Protection	$	-	
8 - Doors and Windows	$	-	
9 - Finishes	$	-	
10 - Specialties	$	-	
11 - Equipment	$	-	
12 - Furnishings	$	-	
13 - Special Construction	$	-	
14 - Conveying Systems	$	-	
15 - Mechanical	$	-	
16 - Electrical	$	-	
17 - Instrumentation and Control	$	-	
Raw Construction Subtotal	**$**	**9,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,250,000	
		Construction Cost Subtotal	**$**	**11,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	1,700,000	
		Total Construction Cost	**$**	**13,450,000**	
	15%	Owner's Reserve for Change Orders	$	2,000,000	
	15%	Engineering Services (Design)	$	2,000,000	
	13%	Construction Management	$	1,700,000	
	12%	Engineering Services During Construction	$	1,600,000	
		TOTAL CAPITAL COST	**$**	**21,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**500,000**	
	Traffic Control (Heavy Urban)	7%	30	11,800	LS	$	42.00	$	500,000	7% of Divisions 2-17
			30							
2 - Sitework								**$**	**8,200,000**	
	48" Open cut pipeline		30	11,800	LF	$	600	$	7,100,000	
	48" Bore and Jack Pipeline & Casing		30	-	LF	$	1,560	$	-	
	48" HDD Pipeline		30	600	LF	$	840	$	500,000	
	48" Microtunnel Pipeline & Casing		30	-	LF	$	2,100	$	-	
	Sheeting and Shorting	7%	30	11,800	LF	$	42.00	$	500,000	
	Potholing (Heavy Urban)	2%	30	11,800	LF	$	12.00	$	100,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**20,000**	
Annual Inspection and Pipeline Maintenance	12,400	LF	$1.63	$	20,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**20,000**	

Table 1-66. NPR+ intertie between Mountain View and Sunnyvale

HydroScience

Project: **Countywide Water Reuse Master Plan**
Aspect: **NPR/NPR+ Intertie**
Mountain View/Sunnyvale
Diam **16 inch**
Length **18,560 feet**
Estimate Type: Planning

Date: 10/8/2019
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 400,000	
2 - Sitework	$ 6,500,000	
3 - Concrete	$ -	
4 - Masonry		
5 - Metals	$ -	
6 - Wood and Plastic	$ -	
7 - Moisture and Thermal Protection	$ -	
8 - Doors and Windows	$ -	
9 - Finishes	$ -	
10 - Specialties	$ -	
11 - Equipment	$ -	
12 - Furnishings	$ -	
13 - Special Construction	$ -	
14 - Conveying Systems	$ -	
15 - Mechanical	$ -	
16 - Electrical	$ -	
17 - Instrumentation and Control	$ -	
Raw Construction Subtotal	**$ 7,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 1,750,000	
		Construction Cost Subtotal	**$ 8,750,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 400,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,300,000	
		Total Construction Cost	**$ 10,450,000**	
	15%	Owner's Reserve for Change Orders	$ 1,600,000	
	15%	Engineering Services (Design)	$ 1,600,000	
	13%	Construction Management	$ 1,400,000	
	12%	Engineering Services During Construction	$ 1,300,000	
		TOTAL CAPITAL COST	**$ 16,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 400,000**	
	Traffic Control (Heavy Urban)	7%	16	18,360	LS	$ 22.40	$ 400,000	7% of Divisions 2-17
			16					
2 - Sitework							**$ 6,500,000**	
	48" Open cut pipeline		16	18,360	LF	$ 320	$ 5,900,000	
	48" Bore and Jack Pipeline & Casing		16	-	LF	$ 832	$ -	
	48" HDD Pipeline		16	200	LF	$ 448	$ 100,000	
	48" Microtunnel Pipeline & Casing		16	-	LF	$ 1,120	$ -	
	Sheeting and Shorting	7%	16	18,360	LF	$ 22.40	$ 400,000	
	Potholing (Heavy Urban)	2%	16	18,360	LF	$ 6.40	$ 100,000	
							$ -	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					**$ 30,000**	
	Annual Inspection and Pipeline Maintenance	18,560	LF	$1.63	$ 30,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 30,000**	

Table 1-67. NPR+ intertie between Sunnyvale and SBWR

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 10/8/2019 Project Number: 437-001-105
Aspect:	**NPR/NPR+ Intertie**	**Diam** **Length**	**30 inch** **14,970 feet**	Prepared By: I Wald Checked By: C Lam
	Sunnyvale/SBWR			Check Date:
Estimate Type: Planning				

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 600,000	
2 - Sitework	$ 9,800,000	
3 - Concrete	$ -	
4 - Masonry		
5 - Metals	$ -	
6 - Wood and Plastic	$ -	
7 - Moisture and Thermal Protection	$ -	
8 - Doors and Windows	$ -	
9 - Finishes	$ -	
10 - Specialties	$ -	
11 - Equipment	$ -	
12 - Furnishings	$ -	
13 - Special Construction	$ -	
14 - Conveying Systems	$ -	
15 - Mechanical	$ -	
16 - Electrical	$ -	
17 - Instrumentation and Control	$ -	
Raw Construction Subtotal	**$ 10,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,500,000	
		Construction Cost Subtotal	**$ 12,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,900,000	
		Total Construction Cost	**$ 15,000,000**	
	15%	Owner's Reserve for Change Orders	$ 2,300,000	
	15%	Engineering Services (Design)	$ 2,300,000	
	13%	Construction Management	$ 2,000,000	
	12%	Engineering Services During Construction	$ 1,800,000	
		TOTAL CAPITAL COST	**$ 23,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 600,000**	
	Traffic Control (Heavy Urban)	7%	30	14,720	LS	$ 42.00	$ 600,000	7% of Divisions 2-17
			30					
2 - Sitework							**$ 9,800,000**	
	48" Open cut pipeline		30	14,720	LF	$ 600	$ 8,800,000	
	48" Bore and Jack Pipeline & Casing		30	-	LF	$ 1,560	$ -	
	48" HDD Pipeline		30	250	LF	$ 840	$ 200,000	
	48" Microtunnel Pipeline & Casing		30	-	LF	$ 2,100	$ -	
	Sheeting and Shorting	7%	30	14,720	LF	$ 42.00	$ 600,000	
	Potholing (Heavy Urban)	2%	30	14,720	LF	$ 12.00	$ 200,000	
							$ -	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 24,000**	
Annual Inspection and Pipeline Maintenance	14,970	LF	$1.63	$ 24,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 24,000**	

Table 1-68. PL-15, 36-inch purified water pipeline from Moffett Field to Sunnyvale WPCP

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/6/2020
				Project Number:	437-001-105
Aspect:	**PL-15. Purified water PL, Moffett Field to Sunnyvale WPCP**	**Diam**	**36 inch**	Prepared By:	J Machorro
		Length	**17,800 feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 900,000	
2 - Sitework		$ 14,300,000	
	Raw Construction Subtotal	**$ 15,200,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,800,000	
		Construction Cost Subtotal	**$ 19,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 900,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,900,000	
		Total Construction Cost	**$ 22,800,000**	
	15%	Owner's Reserve for Change Orders	$ 3,400,000	
	15%	Engineering Services (Design)	$ 3,400,000	
	13%	Construction Management	$ 3,000,000	
	12%	Engineering Services During Construction	$ 2,700,000	
		TOTAL CAPITAL COST	**$ 35,300,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 900,000**	
	Traffic Control (Heavy Urban)	7%	36	17,800	LS	$ 50.40	$ 900,000	7% of Divisions 2-17
			36					
2 - Sitework							**$ 14,300,000**	
	36" Open cut pipeline		36	17,800	LF	$ 720	$ 12,800,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$ 1,872	$ -	
	36" HDD Pipeline		36	300	LF	$ 1,008	$ 300,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$ 2,520	$ -	
	Sheeting and Shoring	7%	36	17,500	LF	$ 50.40	$ 900,000	
	Potholing (Heavy Urban)	2%	36	17,800	LF	$ 14.40	$ 300,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 29,000**	
Total No. Operators	-				
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$ -	
Annual Inspection and Pipeline Maintenance	17,800	LF	$1.63	$ 29,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 29,000**	

Table 1-69. PL-16, 36-inch purified water pipeline from Sunnyvale WPCP to Arques (East)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 5/6/2020
				Project Number: 437-001-105
Aspect:	**PL-16. Purified water PL from Sunnyvale WPCP to Arques (East)**	**Diam**	**36 inch**	Prepared By: J Machorro
		Length	**30,300 feet**	Checked By: C Lam
Estimate Type: Planning				

Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 1,500,000	
2 - Sitework			$ 25,900,000	
		Raw Construction Subtotal	**$ 27,400,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 6,850,000	
		Construction Cost Subtotal	**$ 34,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 1,500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 5,100,000	
		Total Construction Cost	**$ 40,850,000**	
	15%	Owner's Reserve for Change Orders	$ 6,100,000	
	15%	Engineering Services (Design)	$ 6,100,000	
	13%	Construction Management	$ 5,300,000	
	12%	Engineering Services During Construction	$ 4,900,000	
		TOTAL CAPITAL COST	**$ 63,300,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 1,500,000**	
	Traffic Control (Heavy Urban)	7%	36	30,300	LS	$ 50.40	$ 1,500,000	7% of Divisions 2-17
			36					
2 - Sitework							**$ 25,900,000**	
	36" Open cut pipeline		36	30,300	LF	$ 720	$ 21,800,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$ 1,872	$ -	
	36" HDD Pipeline		36	2,250	LF	$ 1,008	$ 2,300,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$ 2,520	$ -	
	Sheeting and Shoring	7%	36	28,050	LF	$ 50.40	$ 1,400,000	
	Potholing (Heavy Urban)	2%	36	30,300	LF	$ 14.40	$ 400,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					**$ 49,000**	
	Total No. Operators		-			
	Average Annual Operator Hours per Year		hours			
	Total Operator Hours per Year		hours	$0	$ -	
	Annual Inspection and Pipeline Maintenance	30,300	LF	$1.63	$ 49,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 49,000**	

Table 1-70. PL-17, 36-inch purified water pipeline from Sunnyvale WPCP to Arques (East)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 5/6/2020 Project Number: 437-001-105
Aspect:	**PL-17. Purified water PL, Sunnyvale WPCP to Arques (East)**	**Diam** **Length**	**36 inch** **11,400 feet**	Prepared By: J Machorro Checked By: C Lam
Estimate Type: Planning				

Cost Summary by Division

Spec. Division			**Subtotal**	**Notes**
1 - General Requirements			$ 600,000	
2 - Sitework			$ 9,100,000	
		Raw Construction Subtotal	**$ 9,700,000**	
Soft Costs	**Metric**	**Value**	**Cost**	**Notes**
	25%	Construction Contingency	$ 2,425,000	
		Construction Cost Subtotal	**$ 12,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,800,000	
		Total Construction Cost	**$ 14,425,000**	
	15%	Owner's Reserve for Change Orders	$ 2,200,000	
	15%	Engineering Services (Design)	$ 2,200,000	
	13%	Construction Management	$ 1,900,000	
	12%	Engineering Services During Construction	$ 1,700,000	
		TOTAL CAPITAL COST	**$ 22,400,000**	

Item	**Description**	**Size or Metric**	**Diameter (in)**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
1 - General Requirements							**$ 600,000**	
	Traffic Control (Heavy Urban)	7%	36	11,400	LS	$ 50.40	$ 600,000	7% of Divisions 2-17
2 - Sitework							**$ 9,100,000**	
	36" Open cut pipeline		36	10,590	LF	$ 720	$ 7,600,000	
	36" Bore and Jack Pipeline & Casing		36		LF	$ 1,872	$ -	
	36" HDD Pipeline		36	810	LF	$ 1,008	$ 800,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$ 2,520	$ -	
	Sheeting and Shorting	7%	36	10,590	LF	$ 50.40	$ 500,000	
	Potholing (Heavy Urban)	2%	36	11,400	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS	**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Labor Costs				**$ 19,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$ -	
Annual Inspection and Pipeline Maintenance	11,400	LF	$1.63	$ 19,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 19,000**	

Table 1-71. PL-18, 36-inch purified water pipeline from Moffett Field to Arques (West)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/6/2020
				Project Number:	437-001-105
Aspect:	**PL-18. Purified water PL, Moffett Field to Arques (West)**	**Diam**	**36 Inch**	Prepared By:	J Machorro
		Length	**12,300 feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	600,000	
2 - Sitework	$	9,900,000	
Raw Construction Subtotal	**$**	**10,500,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,625,000	
		Construction Cost Subtotal	**$**	**13,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	2,000,000	
		Total Construction Cost	**$**	**15,725,000**	
	15%	Owner's Reserve for Change Orders	$	2,400,000	
	15%	Engineering Services (Design)	$	2,400,000	
	13%	Construction Management	$	2,000,000	
	12%	Engineering Services During Construction	$	1,900,000	
		TOTAL CAPITAL COST	**$**	**24,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**600,000**	
	Traffic Control (Heavy Urban)	7%	36 36	12,300	LS	$	50.40	$	600,000	7% of Divisions 2-17
2 - Sitework								**$**	**9,900,000**	
	36" Open cut pipeline		36	11,450	LF	$	720	$	8,200,000	
	36" Bore and Jack Pipeline & Casing		36		LF	$	1,872	$	-	
	36" HDD Pipeline		36	900	LF	$	1,008	$	900,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$	2,520	$	-	
	Sheeting and Shoring	7%	36	11,450	LF	$	50.40	$	600,000	
	Potholing (Heavy Urban)	2%	36	12,300	LF	$	14.40	$	200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**20,000**	
Total No. Operators		-				
Average Annual Operator Hours per Year		hours				
Total Operator Hours per Year		hours	$0	$	-	
Annual Inspection and Pipeline Maintenance	12,300	LF	$1.63	$	20,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**20,000**	

Table 1-72. PL-19, 36-inch purified water pipeline from Arques (West) to Arques (East)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 5/6/2020
		Diam	**36 inch**	Project Number: 437-001-105
Aspect:	**PL-19. Arques (West) to Arques (East)**	**Length**	**12,100 feet**	Prepared By: J Machorro
				Checked By: C Lam
Estimate Type: Planning				

Cost Summary by Division

Spec. Division				Subtotal	Notes
1 - General Requirements			$	1,900,000	
2 - Sitework			$	9,800,000	
		Raw Construction Subtotal	**$**	**11,700,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,925,000	
		Construction Cost Subtotal	**$**	**14,625,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	2,200,000	
		Total Construction Cost	**$**	**17,525,000**	
	15%	Owner's Reserve for Change Orders	$	2,600,000	
	15%	Engineering Services (Design)	$	2,600,000	
	13%	Construction Management	$	2,300,000	
	12%	Engineering Services During Construction	$	2,100,000	
		TOTAL CAPITAL COST	**$**	**27,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**1,900,000**	
	Traffic Control (Heavy Urban)	7%	36	38,320	LS	$	50.40	$	1,900,000	7% of Divisions 2-17
			36							
2 - Sitework								**$**	**9,800,000**	
	36" Open cut pipeline		36	12,100	LF	$	720	$	8,700,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$	1,872	$	-	
	36" HDD Pipeline		36	300	LF	$	1,008	$	300,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$	2,520	$	-	
	Sheeting and Shorting	7%	36	11,800	LF	$	50.40	$	600,000	
	Potholing (Heavy Urban)	2%	36	12,100	LF	$	14.40	$	200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**20,000**	
Total No. Operators		-				
Average Annual Operator Hours per Year		hours				
Total Operator Hours per Year		hours	$0	$	-	
Annual Inspection and Pipeline Maintenance	12,100	LF	$1.63	$	20,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**20,000**	

Table 1-73. PL-20, 48-inch purified water pipeline from Arques (West) to Arques (East)

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 5/6/2020
				Project Number: 437-001-105
Aspect:	**PL-20 Arques (West) to Arques (East)**	**Diam**	**48 inch**	Prepared By: J Machorro
		Length	**12,100 feet**	Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 800,000	
2 - Sitework		$ 13,600,000	
	Raw Construction Subtotal	**$ 14,400,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,600,000	
		Construction Cost Subtotal	**$ 18,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,700,000	
		Total Construction Cost	**$ 21,500,000**	
	15%	Owner's Reserve for Change Orders	$ 3,200,000	
	15%	Engineering Services (Design)	$ 3,200,000	
	13%	Construction Management	$ 2,800,000	
	12%	Engineering Services During Construction	$ 2,600,000	
		TOTAL CAPITAL COST	**$ 33,300,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 800,000**	
	Traffic Control (Heavy Urban)	7%	48	12,100	LS	$ 67.20	$ 800,000	7% of Divisions 2-17
2 - Sitework							**$ 13,600,000**	
	48" Open cut pipeline		48	12,100	LF	$ 960	$ 11,600,000	
	48" Bore and Jack Pipeline & Casing		48		LF	$ 2,496	$ -	
	48" HDD Pipeline		48		LF	$ 1,344	$ -	
	48" Microtunnel Pipeline & Casing		48	300	LF	$ 3,360	$ 1,000,000	
	Sheeting and Shorting	7%	48	12,100	LF	$ 67.20	$ 800,000	
	Potholing (Heavy Urban)	2%	48	12,100	LF	$ 19.20	$ 200,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					**$ 20,000**	
	Total No. Operators		-			
	Average Annual Operator Hours per Year		hours			
	Total Operator Hours per Year		hours	$0	$ -	
	Annual Inspection and Pipeline Maintenance	12,100	LF	$1.63	$ 20,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 20,000**	

Table 1-74. PL-31, 48-inch purified water pipeline from Sunnyvale WPCP to LGRP

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 5/6/2020
				Project Number: 437-001-105
Aspect:	**PL-31. Purified water PL from Sunnyvale WPCP to LGRP**	**Diam**	**48 inch**	Prepared By: J Machorro
		Length	**89,600 feet**	Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 6,000,000	
2 - Sitework		$ 102,100,000	
	Raw Construction Subtotal	**$ 108,100,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 27,025,000	
		Construction Cost Subtotal	**$ 135,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 6,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 20,300,000	
		Total Construction Cost	**$ 161,525,000**	
	15%	Owner's Reserve for Change Orders	$ 24,200,000	
	15%	Engineering Services (Design)	$ 24,200,000	
	13%	Construction Management	$ 21,000,000	
	12%	Engineering Services During Construction	$ 19,400,000	
		TOTAL CAPITAL COST	**$ 250,300,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 6,000,000**	
	Traffic Control (Heavy Urban)	7%	48	89,600	LS	$ 67.20	$ 6,000,000	7% of Divisions 2-17
2 - Sitework							**$ 102,100,000**	
	48" Open cut pipeline		48	87,190	LF	$ 960	$ 83,700,000	
	48" Bore and Jack Pipeline & Casing		48	2,410	LF	$ 2,496	$ 6,000,000	
	48" HDD Pipeline		48		LF	$ 1,344	$ -	
	48" Microtunnel Pipeline & Casing		48	1,420	LF	$ 3.360	$ 4,800,000	
	Sheeting and Shorting	7%	48	87,190	LF	$ 67.20	$ 5,900,000	
	Potholing (Heavy Urban)	2%	48	89,600	LF	$ 19.20	$ 1,700,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 175,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$ -	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table 1-75. PL-32, 48-inch purified water pipeline from Arques (West) to LGRP

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/7/2020
				Project Number:	437-001-105
Aspect:	**PL-32. Purified water PL, from Arques (West) to LGRP**	**Diam**	**48 inch**	Prepared By:	J Machorro
		Length	**72,500 feet**	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements		$	4,900,000	
2 - Sitework		$	84,700,000	
	Raw Construction Subtotal	**$**	**89,600,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	22,400,000	
		Construction Cost Subtotal	**$**	**112,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	5,000,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	16,800,000	
		Total Construction Cost	**$**	**133,800,000**	
	15%	Owner's Reserve for Change Orders	$	20,100,000	
	15%	Engineering Services (Design)	$	20,100,000	
	13%	Construction Management	$	17,400,000	
	12%	Engineering Services During Construction	$	16,100,000	
		TOTAL CAPITAL COST	**$**	**207,500,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**4,900,000**	
	Traffic Control (Heavy Urban)	7%	48	72,500	LS	$	67.20	$	4,900,000	7% of Divisions 2-17
2 - Sitework								**$**	**84,700,000**	
	48" Open cut pipeline		48	72,500	LF	$	960	$	69,600,000	
	48" Bore and Jack Pipeline & Casing		48	1,600	LF	$	2,496	$	4,000,000	
	48" HDD Pipeline		48		LF	$	1,344	$	-	
	48" Microtunnel Pipeline & Casing		48	1,420	LF	$	3,360	$	4,800,000	
	Sheeting and Shoring	7%	48	72,500	LF	$	67.20	$	4,900,000	
	Potholing (Heavy Urban)	2%	48	72,500	LF	$	19.20	$	1,400,000	

ANNUAL O&M COSTS		Quantity	Unit	Value		Cost	Notes
Labor Costs					**$**	**118,000**	
	Total No. Operators		-				
	Average Annual Operator Hours per Year		hours				
	Total Operator Hours per Year		hours	$0	$	-	
	Annual Inspection and Pipeline Maintenance	72,500	LF	$1.63	$	118,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$**	**118,000**	

Table 1-76. PL-33, 36-inch purified water pipeline from Palo Alto AWPF to Sunnyvale WPCP

HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date: 5/7/2020 Project Number: 437-001-105 Prepared By: J Machorro Checked By: C Lam
Aspect:	**PL-33. Purified water PL from Palo Alto AWPF to Sunnyvale WPCP**	**Diam** **Length**	**36 inch** **38,820 feet**	

Estimate Type: Planning

Cost Summary by Division

Spec. Division				Subtotal	Notes
1 - General Requirements				$ 1,900,000	
2 - Sitework				$ 30,800,000	
			Raw Construction Subtotal	**$ 32,700,000**	
Soft Costs		**Metric**	**Value**	**Cost**	**Notes**
		25%	Construction Contingency	$ 8,200,000	
			Construction Cost Subtotal	**$ 40,900,000**	
		9%	Tax on Materials (Applied to half of subtotal)	$ 1,800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
		15%	Overhead and Profit	$ 6,100,000	
			Total Construction Cost	**$ 48,800,000**	
		15%	Owner's Reserve for Change Orders	$ 7,300,000	
		15%	Engineering Services (Design)	$ 7,300,000	
		13%	Construction Management	$ 6,300,000	
		12%	Engineering Services During Construction	$ 5,900,000	
			TOTAL CAPITAL COST	**$ 75,600,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 1,900,000**	
	Traffic Control (Heavy Urban)	7%	36 36	38,320	LS	$ 50.40	$ 1,900,000	7% of Divisions 2-17
2 - Sitework							**$ 30,800,000**	
	36" Open cut pipeline		36	38,320	LF	$ 720	$ 27,600,000	
	36" Bore and Jack Pipeline & Casing		36	-	LF	$ 1,872	$ -	
	36" HDD Pipeline		36	650	LF	$ 1,008	$ 700,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$ 2,520	$ -	
	Sheeting and Shoring	7%	36	37,670	LF	$ 50.40	$ 1,900,000	
	Potholing (Heavy Urban)	2%	36	38,320	LF	$ 14.40	$ 600,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 63,000**	
Total No. Operators		-			
Average Annual Operator Hours per Year		hours			
Total Operator Hours per Year		hours	$0	$ -	
Annual Inspection and Pipeline Maintenance	38,820	LF	$1.63	$ 63,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 63,000**	

Table 1-77. PL-44, 36-inch pipeline from PA AWPF to West Pipeline at Stevens Creek Blvd (West County TWA)

HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PL-44 - PA AWPF to West Pipeline at Stevens Creek Blvd (West County TWA)**

Diam **36 inch**
Length **56,600 feet**

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 2,900,000	
2 - Sitework	$ 45,500,000	
Raw Construction Subtotal	**$ 48,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 12,000,000	
		Construction Cost Subtotal	**$ 60,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 2,700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 9,000,000	
		Total Construction Cost	**$ 71,700,000**	
	15%	Owner's Reserve for Change Orders	$ 10,800,000	
	15%	Engineering Services (Design)	$ 10,800,000	
	13%	Construction Management	$ 9,300,000	
	12%	Engineering Services During Construction	$ 8,600,000	
		Total Capital Cost	**$ 111,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 2,900,000**	
	Traffic Control (Heavy Urban)	7%	36	56,600	LS	$ 50.40	$ 2,900,000	7% of Divisions 2-17
			36					
2 - Sitework							**$ 45,500,000**	
	36" Open cut pipeline		36	54,350	LF	$ 720	$ 39,100,000	
	36" Bore and Jack Pipeline & Casing		36	550	LF	$ 1,872	$ 1,000,000	
	36" HDD Pipeline		36	1,700	LF	$ 1,008	$ 1,700,000	
	36" Microtunnel Pipeline & Casing		36	-	LF	$ 2,520	$ -	
	Sheeting and Shorting	7%	36	56,600	LF	$ 50.40	$ 2,900,000	
	Potholing (Heavy Urban)	2%	36	54,350	LF	$ 14.40	$ 800,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 92,000**	
Annual Inspection and Pipeline Maintenance	56,600	LF	$1.63	$ 92,000	
TOTAL ANNUAL O&M COSTS				**$ 92,000**	

Table 1-78. PL-44, . Westsdie AWPF (West County Treated Water Augmentation)

Brown AND Caldwell

Focus: **Cost Summary**
Element: **AWPF (TWA)**
Capacity / Treatment: **24 mgd**
Location: **Palo Alto**

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		$	135,000,000
Contingency - Treatment Facility	25%	$	34,000,000
Construction Cost Subtotal		$	169,000,000
Tax on Materials (applied to half of subtotal)	9%	$	8,000,000
General Contractor Overhead and Profit	15%	$	26,000,000
Estimated Total Construction Cost		**$**	**203,000,000**
Owner's Reserve for Change Orders	15%	$	31,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	31,000,000
Construction Management	13%	$	27,000,000
Engineering Services During Construction	12%	$	25,000,000
Total Capital Cost		**$**	**317,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	3,530,000
Energy/Power	$	5,760,000
Chemicals	$	2,910,000
Labor	$	3,850,000
Total Annual O&M Cost	**$**	**16,050,000**

Replacement and Renewal Costs*	
100-yr Lifecycle (present value, $2019)	Not calculated
30-yr Lifecycle (present value, $2019)	Not calculated

*See Attachment C, Basis of Cost for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	16,170,000
Annual O&M Cost		$	16,050,000
Annual R&R Cost	annual average of 30-yr lifecycle		Not calculated
Total Annual Cost			**Not calculated**
Annual Yield	AF		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)			**Not calculated**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	12,292,000	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	9,474,800	$ 0
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	750,000	1%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	1,000,000	1%
Division 10 – Specialties	$	-	0%
	$	-	0%
Division 11 – Equipment			
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	4,097,300	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	16,389,200	12%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	4,054,200	3%
Division 32 – Exterior Improvements	$	111,200	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	16,547,700	12%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	22,530,900	17%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	47,964,000	36%
TOTAL	**$**	**135,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$ 122,919,300	10% of Divisions 2-47	$ 12,292,000	
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500	
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		39,685	CY		$ 11.78			$ 467,500	
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000	
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		11,261	CY		$ 58.49			$ 658,700	
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500	
Division 31 – Earthwork	Sitework	Gravel		10,294	SY		$ 4.63			$ 47,700	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineers estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		1,200	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 449,400	Unit cost was obtained interpolating available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 449,400	9' to 14' of cover	$ 22,500	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ 119,500	Ozone and LOX Area
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ 56,800	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactors Slab		320	CY		$ 645		See Site Work and Concrete Tab	$ 206,400	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactor Walls		576	CY		$ 1,090		See Site Work and Concrete Tab	$ 627,900	Ozone and LOX Area
Division 03 – Concrete	Concrete	BAC Filter Slab		427	CY		$ 645		See Site Work and Concrete Tab	$ 275,200	BAC
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ 327,000	BAC
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Chlorine Contact Basin Slab		538	CY		$ 645		See Site Work and Concrete Tab	$ 346,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Walls, including interior channel Walls		233	CY		$ 1,090		See Site Work and Concrete Tab	$ 253,600	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Suspended Slab		202	CY		$ 645		See Site Work and Concrete Tab	$ 130,100	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		4,515	CY		$ 645		See Site Work and Concrete Tab	$ 2,912,200	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 53			$ 111,200	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Lime Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		60,950	SF		$ 219		265' x 230'; furnished and installed	$ 13,322,400	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	2	EA	$ 3,650,000			From DN Tanks cost proposal, need two 4 MG tanks	$ 7,300,000	Prestressed Concrete Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Storage Silos	17,500	2	EA	$ 183,750				$ 367,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Slurry Batching Tank	2,000	2	EA	$ 5,793				$ 11,600	Chemical Tanks

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Lime Slurry Storage Tank	10,000	2	EA	$ 105,000				$ 210,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz. Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 47,964,000	30% of Equipment Costs	$ 14,389,200	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 14,389,200	5% of Piping Allowance	$ 719,500	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 47,964,000	30% of Equipment Costs	$ 14,389,200	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 16,389,200	25% of Electrical Costs	$ 4,097,300	
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$ 1,046,200	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,220,000	2% of Pumping Equipment Cost	$ 24,400	
O&M	Consumables	Electrical Consumables		2%	% of			$ 16,389,200	2% of Electrical Cost	$ 327,800	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 4,097,300	2% of Instrumentation & Controls Cost	$ 82,000	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ 290,800	
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ 14,900	
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ 21,800	
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ 30,500	
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ 11,900	
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ 4,000	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,176,293	kWh		$ 0.10			$ 121,700	
O&M	Power	Waste Equalization Pumps		196,049	kWh		$ 0.10			$ 20,300	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **24 mgd**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ 21,100	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	

Table 1-79. PS-18, pump station to convey Palo Alto AWPF purified water to West Pipeline at Stevens Creek (West County TWA)

HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PS-18 - PS from PA AWPF to West Pipeline at Stevens Creek (West County TWA)**

Flow **16,667** **gpm**
TDH **500** **feet**
Horsepower **3,570** **hp**

Date: 5/13/2020
Project Number: 437.001.105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,280,000	
2 - Sitework	$	1,450,000	
3 - Concrete	$	1,430,000	
11 - Equipment	$	1,450,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,500,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,610,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,150,000	
		Construction Cost Subtotal	**$**	**15,760,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	710,000	
	15%	Overhead and Profit	$	2,360,000	
		Total Construction Cost	**$**	**18,830,000**	
	15%	Owner's Reserve for Change Orders	$	2,820,000	
	15%	Engineering Services (Design)	$	2,820,000	
	13%	Construction Management	$	2,450,000	
	12%	Engineering Services During Construction	$	2,260,000	
		TOTAL CAPITAL COST	**$**	**29,180,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**1,280,000**	
	Mobilization/Demobilization	10%	1	LS		$	1,133,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,450,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	250,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	-	within PA AWPF
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	50,000	
3 - Concrete						**$**	**1,430,000**	
	Structural Concrete	18 inch	1	LS		$	500,000	
	Vaults	12 inch	1	LS		$	200,000	
	Equipment slabs	12 inch	1	LS		$	150,000	
	Building slabs	18 inch	1	LS		$	75,000	
	Miscellaneous Concrete	18 inch	1	LS		$	200,000	
	CMU Building	25 X 40 foot	1	LS		$	300,000	
11 - Equipment						**$**	**1,450,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
	Vertical turbine pumps, cans, housing		1	LS		$ 1,200,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 150,000	
15 - Mechanical						**$ 1,000,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						**$ 3,500,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 1,000,000	
17 - I&C						**$ 2,500,000**	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 169,000**	
	Equipment		2%		$1,450,000	$ 29,000	2% of Division 11
	Mechanical		2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical		2%		$3,500,000	$ 70,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						**$ 1,516,000**	
	Electricity Requirement	3,570 hp	9,474,391	kWh	$0.16	$ 1,516,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,685,000**	

Appendix A-7: Evaluation and Risk Assessment Tool

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Appendix A-7:

Evaluation and Risk Assessment Tool

This appendix describes the approach, methods, and key findings related to evaluating reuse portfolios and assessing risks.

Section 1: Evaluation Tool

The evaluation tool is used to compare portfolios relative to one another with respect to prioritization criteria identified by Valley Water and Partner Agency staff, who collectively form the Countywide Water Reuse Master Plan (Master Plan) Project Partner Group (PPG). The five evaluation criteria reflect program goals and input from the PPG and are further defined by 19 sub-criteria. Several program goals that are important to PPG members are not reflected in the latest version of the criteria and sub-criteria because the evaluation tool focuses on sub-criteria that distinguish between portfolios and set them apart from one another. All portfolios protect groundwater and surface water quality, as required by Valley Water.

As conditions change and new information becomes available, it is anticipated that portfolios will perform differently with respect to the criteria and sub-criteria, and results of the tool will change.

1.1 Approach and Methodology

In October 2018, Valley Water hosted a meeting with its Partner Agencies, and the PPG reached collective agreement on five evaluation criteria representing broad categories with descriptions further defining attributes of each. At that early stage in the project, the criteria served an anticipated purpose of prioritizing alternatives with the objective of recommending one alternative to proceed to implementation. As such, the PPG also conferred and agreed on weighting factors pertaining to the five criteria (Table 1-1).

Table 1-1. Evaluation Criteria and Previously Established Weighting

Criterion	Notes	Weighting
Economics	Including 30-year life-cycle costs and unit costs that may directly impact customer affordability.	25%
Supply reliability	Including yield (projected production of reuse water) and utilization (amount of water the delivery point can hold/use).	25%
Environmental and social impacts/benefits	Including energy use, environmental/social justice, local reuse benefit (i.e., product water stays in service area), and water rights equity.	20%
Ease of implementation and permitting/regulatory considerations	Including partnerships/agreements, public health regulatory compliance, environmental discharge compliance, design readiness, NEPA/CEQA and permit requirements, and public acceptance/support.	15%
Engineering feasibility	Including the need for a pilot study, ease of pipeline construction, land acquisition/ownership, site preparation requirements, and ease of operation.	15%
	Total	100%

As the project progressed, Valley Water opted to shift the approach from selecting one recommended alternative to evaluating multiple portfolios to allow flexibility in implementation. Given this shift, the Project Team established an approach and methodology to evaluate project portfolios/options in a manner that readily allows sensitivity testing to determine how portfolios and options compare with variable weighting factor scenarios. In addition, the approach aims to avoid arbitrary and subjective scoring by taking the following steps.

1. **Sort quantitative and qualitative sub-criteria and define respective scoring scales.** The identified sub-criteria (Table 1-2) are applied differently based on whether they are quantitative or qualitative.
   - Quantitative sub-criteria are numerical/design characteristics (e.g., estimated costs, energy use, or purified water production) and scored using actual values.
   - Qualitative characteristics are not as easy to measure. Each portfolio/option is evaluated relative to others using an increasing positive scale ranging from 1 to 2 (e.g., a binary option where 1= no benefit; and 2 = benefit) to 1 to 4 (i.e., where 1 = less benefit and/or greater risk; and 4 = more benefit and/or lower risk).
   - Regulatory criteria are qualitative and based on the comparison of Portfolios' regulatory strategy described in Appendix B-1 and presented in Tables 1-3 and 1-4.
2. **Score each portfolio/option based on each sub-criterion using Table 1-2 score definitions.** Developing scores begins by populating “raw scores” (i.e., actual value for quantitative sub-criteria or rating based on the respective qualitative sub-criteria scale), as shown in Table 1-5.
3. **Convert Scores to a normalized range of 0 to 1.** To compare scores in a single framework, normalize the raw scores on a 0 to 1 scale. Conversion varies by type of sub-criterion:
   - For quantitative sub-criteria where higher values provide more benefit (e.g., yield): Divide each raw score by the maximum possible raw score.

     score ÷ highest score = 0 to 1 normalized score (a percentage)
   - For quantitative sub-criteria where lower values provide more benefit (e.g., cost or energy use): Multiply each raw score by the inverse of the lowest possible raw score.

     score × (1÷lowest score) = 0 to 1 normalized score (a percentage)
   - For qualitative sub-criteria: Use the highest possible rating based on the defined sub-criterion range as the denominator. Divide each score/rating by the denominator.

   score ÷ highest score = 0 to 1 normalized score (a percentile)

   Converted scores are presented in Table 1-6.
4. **Calculate criteria and total portfolio/option scores.** Within each criterion, sum sub-criteria scores to arrive at a criterion score. After applying the respective weighting factor to each criterion, criteria scores can be summed to determine the total score for a portfolio/option.

In converting quantitative and qualitative criteria to a normalized and comparable scale, this approach avoids the risk of two forms of mathematical skewing that can occur with scorecard comparison tools. If quantifiable values are converted to simpler scales or bins, the relative difference between them can be lost. Likewise, if qualitative factors are converted into numeric scales (e.g., 1, 2, 3, 4, symbolizing poor, fair, good, best), the appearance both visually and mathematically is that a score of 4 is twice as good as a score of 2, though the intent is simply to establish that the alternative with a 4 is better than that with a 2. Because it is a subjective factor, the extent of relative benefit is uncertain. The approach used in this evaluation avoids both types of skew by converting numeric values to comparative percentages and qualitative scales into percentiles, which indicate how many alternatives are less preferred.

During score "conversion" to a 0 to 1 scale, raw scores for quantitative sub-criteria that are on a positive scale—where larger values provide more benefit, such as potable reuse (PR) water yield—were divided by the maximum score (the largest value assigned to a portfolio within that sub-criterion). Quantitative sub-criteria such as cost or energy use where lower values provide more benefit were converted by dividing the minimum portfolio raw score by the raw score for the portfolio being evaluated. Qualitative sub-criteria percentiles indicate how many other portfolios over which that portfolio is preferred. If one portfolio is preferred over four other portfolios for a sub-criterion, it would receive a score of 1 ([4 portfolios of relative lower preference]/[4 total other portfolios]). A portfolio that is not preferred over any others would receive a score of zero. Using this method, it does not matter that the qualitative criteria had variable scales (0 to 2 vs. 0 to 4), as all scores are normalized to 0, 0.25, 0.5, 0.75, or 1. Converted scores are shown in Table 1-6.

Evaluation criteria can be evenly weighted (such that each equally contributes to the overall portfolio score) or assigned individual weights to reflect relative importance of each, so long as the sum of criteria weights equals 1 (i.e., 100%). To test the impact of adjusting weighting values on portfolio scores and relative rankings, four variations were considered and applied to converted scores (Table 1-7). Sub-criteria weights represent criteria weights divided by the number of sub-criteria.

Figure 1-1 illustrates how portfolio scores vary when criteria and sub-criteria weights are altered. Figure 1-1(a) presents criteria weighting taken from the October 2018 PPG meeting. Figure 1-1(b) presents equal criteria weighting: all criteria receive a 20 percent weight, and individual sub-criteria are less important. Figure 1-1(c) presents a scenario with equally weighted sub-criteria; each sub-criteria receives a 5.2 percent weight, and criteria that have the most sub-criteria are therefore weighted most heavily and influence overall portfolio scores the most. As an experiment, Figure 1-1(d) is included to heavily weight one criterion—cost—and no other criteria.

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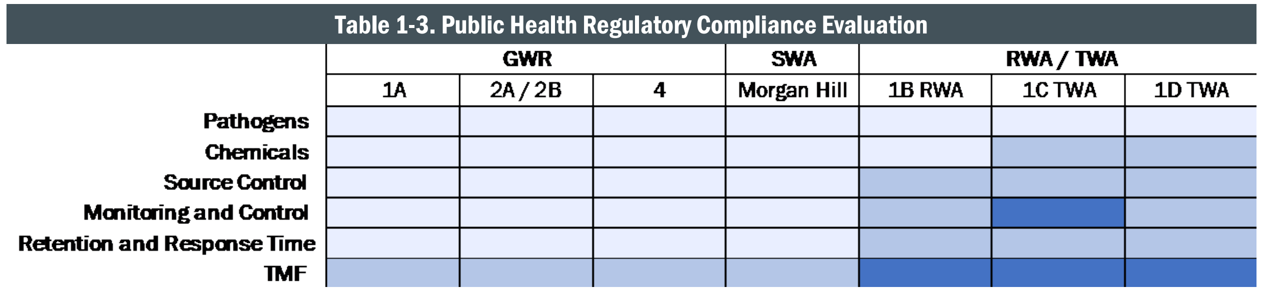
Table 1-2. Portfolio Prioritization Criteria Definition and Score Ranges

Criteria	Sub-criteria	Quantitative (with units) or Qualitative	Most favorable raw score (lowest/highest)	Score range/scale			
				1 (less benefit)	2	3	4 (more benefit)
1. Economics	Unit cost of annual yield ($/AF) – 30-year life-cycle AF using upper-bound yield, including reverse osmosis concentrate (ROC) Management	$/AF	2,500				
	Estimated 30-year life-cycle costs (capital, O&M, R&R) excluding ROC Management - present value in millions	$, millions	940 (lowest)				
2. Countywide (regional) supply reliability	Anticipated PR annual yield using lower-bound flow projection	AFY	24,000 (highest)				
	Purified water usage (limited by delivery point)	AFY	24,000 (highest)				
3. Environmental and social impacts/benefits	Minimizing carbon footprint (energy use as a surrogate)	MWh	62,800 (lowest)				
	Environmental and social justice	Qualitative	2 (highest)	• Inequitable allocation of resources and benefits; lower income areas receive disproportionate impacts	• Equitable allocation of resources and benefits; well-mitigated and distributed impacts (e.g., equally affecting varying income and minority areas)		
	Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area	Qualitative	3 (highest)	• Retains <50% of product water in wastewater agency service area (rate payers may not benefit)	• Retains >50% of product water in wastewater agency service area	• Fully retains product water within wastewater agency service area (rate payers will benefit)	
	Equity in supply benefits (with respect to water rights)	Qualitative	3 (highest)	• Portfolio diverts supply away from an area with fewer or less secure water rights	• Neutral (i.e., no measurable local supply benefits or impacts to water security)	• Portfolio yields supply benefit to an area/retailer with less secure water rights	
4. Ease of implementation and regulatory compliance	Willing partner(s) interested in collaborating	Qualitative	3 (highest)	• Agencies communicating but agreement not being discussed	• Approval in process	• Agreements and/or governance structure established	
	Ease of public health regulatory compliance – see Table 1-3 for results.	Qualitative	4 (highest)	• Low ranking with regard to public health criteria: pathogens, chemicals, source control, monitoring and control, retention and response time, and technical, managerial, and financial (TMF) capacity • Scoring resulted in more than 4 medium or dark blue boxes, with more than 1 dark blue box (see Table 1-3).	• Medium-low ranking with regard to public health criteria: pathogens, chemicals, source control, monitoring and control, retention and response time, and TMF capacity. • Scoring resulted in more than 4 medium or dark blue boxes, with 1 dark blue box (see Table 1-3)	• Medium-high ranking with regard to public health criteria: pathogens, chemicals, source control, monitoring and control, retention and response time, and TMF capacity. • Scoring resulted in 3 or 4 medium or dark blue boxes, with 0 or 1 dark blue box (see Table 1-3)	• High ranking with regard to public health criteria: pathogens, chemicals, source control, monitoring and control, retention and response time, and TMF capacity. • Scoring resulted in 2 or fewer medium blue boxes and no dark blue boxes (see Table 1-3)
	Ease of environmental discharge regulatory compliance – see Table 1-4 for results.	Qualitative	3 (highest)	• 1 or more medium or dark blue box (see Table 1-4).	• No medium or dark blue boxes (see Table 1-4)	• No environmental discharges	
	Design readiness	Qualitative	3 (highest)	• Conceptual studies and designs not yet started	• Conceptual studies and designs in progress	• Conceptual studies and designs prepared	
	Anticipated permit requirements	Qualitative	3 (highest)	• Section 401/404 permit required; Section 7 consultation effort substantial; Section 106 consultation effort substantial; and more than 6 likely endangered species that may require habitat mitigation prior to construction	• Section 401/404 permit required; Section 7 consultation effort moderate; Section 106 consultation effort moderate; and fewer than 6 likely endangered species that may require habitat mitigation prior to permitting	• Section 401/404 permit may not be required; Section 7 consultation effort minimal; Section 106 consultation not required; and fewer than 5 likely endangered species that may require habitat mitigation prior to permitting	
	Public acceptance/support (for potable reuse and use of site(s) for new facilities)	Qualitative	3 (highest)	• Known public unease with PR or known public unease with proposed use of site(s) for new facilities	• Public support neutral or unknown	• Known public support of elements of PR plans and/or proposed use of site(s) for new facilities	

Table 1-2. Portfolio Prioritization Criteria Definition and Score Ranges

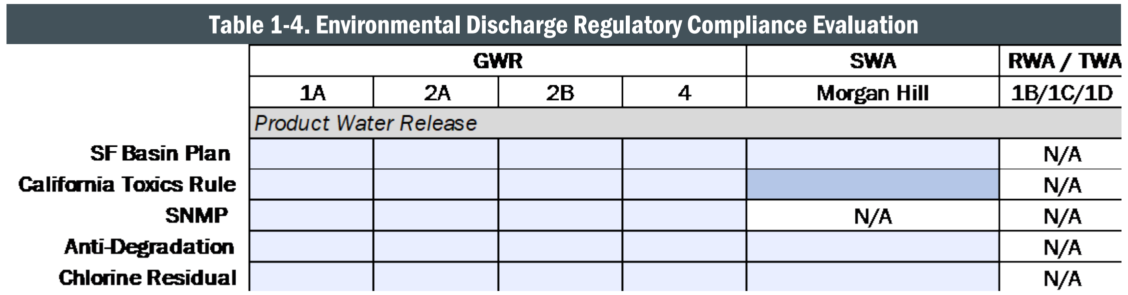
Criteria	Sub-criteria	Quantitative (with units) or Qualitative	Most favorable raw score (lowest/highest)	Score range/scale			
				1 (less benefit)	2	3	4 (more benefit)
5. Engineering, construction, and operations	Need for pilot study (treatment technology proven at full scale)	Qualitative	2 (highest)	• Pilot study needed	• No pilot study needed		
	Ease of pipeline construction	Qualitative	2 (highest)	• Proposed pipeline alignments have significant potential construction or engineering challenges, such as crowded corridors (i.e., existing utilities conflicts), higher traffic impacts, need for more trenchless construction, additional right of way.	• Proposed pipeline alignments do not have known challenges with other utilities, traffic, or engineering challenges.		
	Land acquisition/ownership	Qualitative	2 (highest)	• Land is not currently available for use. For example, voter approval is required for site use, or land is held privately and will need to be purchased.	• No known land acquisition issues other than price negotiation		
	Site preparation requirements	Qualitative	2 (highest)	• Significant site work required before site is ready for construction	• Minimal site work required		
	Ease of operation	Qualitative	3 (highest)	• Facility operation requires more technical expertise • Most (5+) unit processes to operate	• Facility operation requires moderate technical expertise • Moderate number (4) of unit processes to operate	• Facility operation is simple • Least number (3-) of unit processes to operate	

Table 1-3. Public Health Regulatory Compliance Evaluation



	GWR			SWA	RWA / TWA		
	1A	2A / 2B	4	Morgan Hill	1B RWA	1C TWA	1D TWA
Pathogens	░	░	░	░	░	░	░
Chemicals	░	░	░	░	░	▒	▒
Source Control	░	░	░	░	▒	▒	▒
Monitoring and Control	░	░	░	░	▒	█	▒
Retention and Response Time	░	░	░	░	▒	▒	▒
TMF	▒	▒	▒	▒	█	█	█

Table 1-4. Environmental Discharge Regulatory Compliance Evaluation



	GWR				SWA	RWA / TWA
	1A	2A	2B	4	Morgan Hill	1B/1C/1D
	Product Water Release					
SF Basin Plan	░	░	░	░	░	N/A
California Toxics Rule	░	░	░	░	▒	N/A
SNMP	░	░	░	░	N/A	N/A
Anti-Degradation	░	░	░	░	░	N/A
Chlorine Residual	░	░	░	░	░	N/A

Table 1-5. Evaluation Matrix of Raw Scores

Criteria	Sub-criteria	Most favorable raw score (lowest/highest)	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4
1. Economics	Unit cost of annual yield ($/AF) – 30-year life-cycle AF using upper-bound yield, including ROC Management	2,500	2,500	2,600	2,500	2,600	2,900	2,900	3,000
	Estimated 30-year life-cycle costs (capital, O&M, R&R), excluding ROC Management - present value in millions	940 (lowest)	950	965	940	985	1,060	1,060	1,120
2. Countywide (regional) supply reliability	Anticipated PR annual yield using lower-bound flow projection	24,000 (highest)	24,000	24,000	24,000	24,000	17,000	17,000	17,000
	Purified water usage (assumed delivery point capacity)	24,000 (highest)	19,000	19,800	24,000	24,000	19,000	19,000	19,000
3. Environmental impacts/benefits and sustainability	Minimizing carbon footprint (energy use as a surrogate)	62,800 (lowest)	62,800	70,000	71,700	71,700	66,400	63,000	66,300
	Environmental and social justice	2 (highest)	2	2	1	1	1	1	1
	Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area	3 (highest)	2	2	3	3	1	1	1
	Equity in supply benefits (with respect to water rights)	3 (highest)	1	2	2	2	3	3	3
4. Ease of implementation and regulatory compliance	Willing partner(s) interested in collaborating	3 (highest)	1	1	1	1	3	2	2
	Ease of public health regulatory compliance	3 (highest)	4	3	1	2	4	4	4
	Ease of environmental discharge regulatory compliance	2 (highest)	1	2	2	2	1	1	1
	Design readiness	3 (highest)	3	2	1	1	1	1	1
	Anticipated permit requirements	3 (highest)	2	2	2	2	3	1	1
	Public acceptance/support (for potable reuse and use of site(s) for new facilities)	3 (highest)	3	2	1	1	3	2	2
5. Engineering, construction, and operations	Need for pilot study (treatment technology proven at full scale)	2 (highest)	2	1	1	1	2	2	2
	Ease of pipeline construction	2 (highest)	2	1	1	1	1	1	1
	Land acquisition/ownership	2 (highest)	2	2	2	2	1	2	1
	Site preparation requirements	2 (highest)	2	2	2	2	2	1	1
	Ease of operation	3 (highest)	3	2	1	1	3	3	3

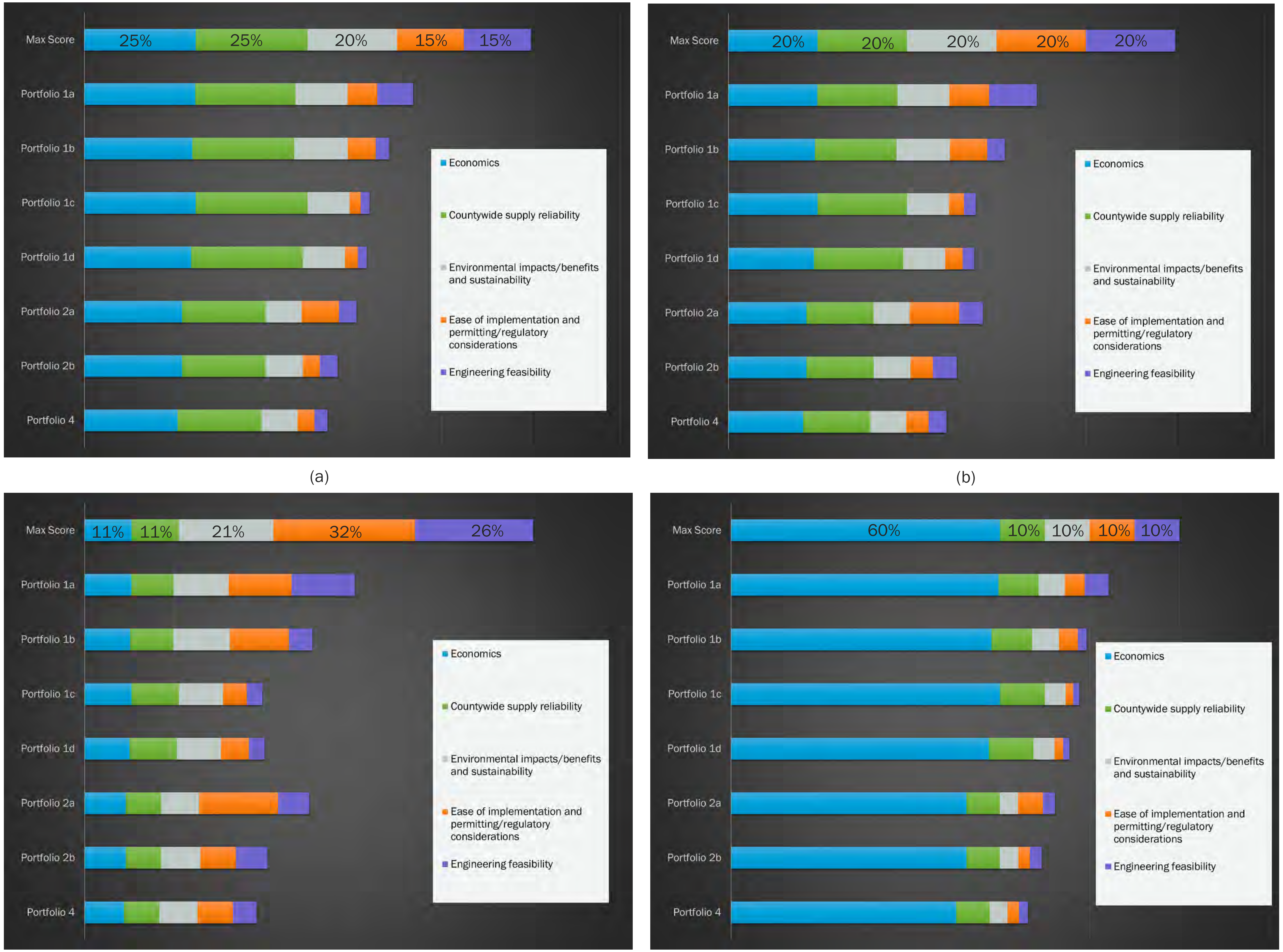
Table 1-6. Evaluation Matrix of Converted Scores

Criteria	Sub-criteria	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4
1. Economics	Unit cost of annual yield ($/AF) – 30-year life-cycle AF using upper-bound yield	1.00	0.96	1.00	0.96	0.86	0.86	0.83
	Estimated 30-year life-cycle costs (capital, O&M, R&R) - present value in millions	0.99	0.97	1.00	0.95	0.89	0.89	0.84
2. Countywide (regional) supply reliability	Anticipated PR annual yield using lower bound flow projection	1.00	1.00	1.00	1.00	0.71	0.71	0.71
	Purified water usage (assumed delivery point capacity)	0.79	0.83	1.00	1.00	0.79	0.79	0.79
3. Environmental impacts/benefits and sustainability	Minimizing carbon footprint (energy use as a surrogate)	1.00	0.90	0.88	0.88	0.95	1.00	0.95
	Environmental and social justice	0.83	0.83	0.00	0.00	0.00	0.00	0.00
	Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area	0.50	0.50	0.83	0.83	0.00	0.00	0.00
	Equity in supply benefits (with respect to water rights)	0.00	0.17	0.17	0.17	0.67	0.67	0.67
4. Ease of implementation and regulatory compliance	Willing partner(s) interested in collaborating	0.00	0.00	0.00	0.00	1.00	0.67	0.67
	Ease of public health regulatory compliance	0.50	0.33	0.00	0.17	0.50	0.50	0.50
	Ease of environmental discharge regulatory compliance	0.00	0.67	0.67	0.67	0.00	0.00	0.00
	Design readiness	1.00	0.83	0.00	0.00	0.00	0.00	0.00
	Anticipated permit requirements	0.33	0.33	0.33	0.33	1.00	0.00	0.00
	Public acceptance/support (for potable reuse and use of site(s) for new facilities)	0.83	0.33	0.00	0.00	0.83	0.33	0.33
5. Engineering, construction, and operations	Need for pilot study (treatment technology proven at full scale)	0.50	0.00	0.00	0.00	0.50	0.50	0.50
	Ease of pipeline construction	1.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition/ownership	0.33	0.33	0.33	0.33	0.00	0.33	0.00
	Site preparation requirements	0.33	0.33	0.33	0.33	0.33	0.00	0.00
	Ease of operation	0.50	0.33	0.00	0.00	0.50	0.50	0.50

🟩	=	*Dark green represents a normalized score of "1," and represents the highest scoring portfolio(s).*
🟩	=	*Represents a normalized score of 0.75*
🟩	=	*Represents a normalized score of 0.5*
🟩	=	*Represents a normalized score of 0.25*

Table 1-7. Evaluation Criteria, Sub-Criteria, and Weighting Factors

	Weight of Criteria				Sub-Criteria (used to further define and score criteria)	Weight of Individual Sub-Criteria			
Criteria	Scenario A: PPG Weights from Oct. 2018	Scenario B: Equal Criteria Weights	Scenario C: Equal Sub-Criteria Weights	Scenario D: Heavily Weighted Economics		Scenario A: PPG Weights from Oct. 2018	Scenario B: Equal Criteria Weights	Scenario C: Equal Sub-Criteria Weights	Scenario D: Heavily Weighted Economics
Economics	25%	20%	10.5%	60%	Unit cost of annual yield of PR supply: 30-year Estimated life-cycle costs: 30-year	12.5%	10%	5.3%	30%
Countywide (regional) supply reliability	25%	20%	10.5%	10%	Anticipated PR annual yield (lower bound) Purified water usage (assumed delivery point capacity)	12.5%	10%	5.3%	5%
Environmental impacts/benefits and sustainability	20%	20%	21.1%	10%	Minimizing carbon footprint (energy use as a surrogate) Environmental and social justice Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area Equity in supply benefits (with respect to water rights)	5%	5%	5.3%	2.5%
Ease of implementation and regulatory compliance	15%	20%	31.6%	10%	Willing partner(s) interested in collaborating Ease of public health regulatory compliance Ease of environmental discharge regulatory compliance Design readiness Anticipated permit requirements Public acceptance/support	2.5%	3.3%	5.3%	1.7%
Engineering feasibility	15%	20%	26.3%	10%	Need for pilot study (treatment technology proven at full scale) Ease of pipeline construction Land acquisition/ownership Site preparation requirements Ease of operation	3%	4%	5.3%	2%



(a)

(b)

(c)

(d)

Figure 1-1. Evaluation results using: (a) criteria weights from October 2018 PPG meeting, (b) equal criteria weights, (c) equal sub-criteria weights, and (d) heavily weighted toward economics

1.2 Portfolio Comparison

The following high-level narrative compares key aspects of North County portfolios as rooted in the Master Plan objectives and guiding principles.

1.2.1 Economics

In scoring portfolios by economics, this analysis uses two sub-criteria.

1. **Unit cost of projected water yield in dollars per AF, 30-year life cycle –** This quantitative sub-criterion favors the two lowest-cost portfolios, Portfolio 1a and 1c, with 1b and 1d following closely behind. Portfolio 4 scores the lowest as it has the highest unit cost in dollars per AF.
2. **Estimated life-cycle costs, 30-year life cycle –** Portfolio 1c scores the highest, as it has the lowest 30-year life-cycle cost, and Portfolio 4 scores the lowest.

1.2.2 Countywide (Regional) Supply Reliability

The countywide (regional) supply reliability criterion looks at:

1. **Anticipated PR annual yield using lower-bound flow projection –**Portfolios 1a through d score the highest as they have adequate source water to reach the 24,000 acre-feet per year (AFY) PR goal. Portfolios 2a, 2b, and 4 have more uncertainty about flow availability: the Project Team assumed an annual PR yield of 17,000 AFY using lower-bound (or flat-line) flow projections. See Appendix A-2 for details about flow calculation assumptions.
2. **Purified water usage (assumed delivery point capacity) –** Portfolios 1c and 1d, the two TWA options, score the highest using delivery point capacity assumptions outlined in Appendix A-2.

1.2.3 Environmental Impacts/Benefits and Sustainability

This criterion is made up of four sub-criteria:

1. **Minimizing carbon footprint** (using energy use as a surrogate for greenhouse gas emissions) – Energy use, including AWPF and pump station annual electricity use but not ROC Management energy use, is between 62,800 megawatts per hour (MWh) and 71,700 MWh per year for all portfolios. Portfolio 1a has the lowest energy use and scores the highest, followed closely by Portfolio 2b. Portfolios 1c and 1d use the most energy and score the lowest, followed closely by Portfolio 1b that uses nearly as much energy. The additional ozone-(biological activated carbon (BAC) processes added a significant electricity load to Portfolios 1b, 1c, and 1d, driving up those portfolios' energy uses.
2. **Environmental and social justice –** Scores for environmental and social justice are based on perceived equity in resource allocation, such as negative impacts of reuse affecting low-income or minority areas (i.e., communities planned to receive purified water as part of their drinking water supply, and communities in close proximity to facilities/construction). Portfolio 1a, 1b, 1c, and 1d would build AWPFs in an area far away from surrounding communities, whereas Portfolios 2a, 2b, and 4 have AWPF locations closer to lower-income, minority areas that might be affected by the construction. 1c and 1d will serve TWA water along the East Pipeline that includes disadvantaged areas of San José.[1]
3. **Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area** – Portfolios 1b, 1c, and 1d receive the highest score because RWA and TWA delivery points are in areas of San José that are fully within the San José/Santa Clara

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[1] The Project Team used the California Department of Water Resources Disadvantaged Communities Mapping Tool to locate disadvantaged communities (using the Block Group 2016 layer); https://gis.water.ca.gov/app/dacs/

Regional Wastewater Facility (SJ/SC RWF) service area. Portfolio 1a, 2a, 2b, and 4 receive moderate scores because, as GWR projects, each will benefit the entire groundwater basin rather than just the respective service area.

4. **Equity in supply benefits (with respect to water rights)** – Portfolios 2a, 2b, and 4 receive the highest score because they take source water from wastewater service areas with secure water rights and recharge the groundwater to benefit customers throughout North County (including areas will less secure water rights). Portfolio 1b, 1c, and 1d receive moderate scores: they have a neutral impact on equity because RWA and TWA keep supply within the same service area. Portfolio 1a takes supply from the least "water secure" area within North County and sends it for groundwater recharge to benefit customers throughout North County (including areas with more secure water rights).

1.2.4 Ease of Implementation and Permitting/Regulatory Considerations

Implementation and permitting/regulatory considerations pertain to the following six sub-criteria.

1. **Willing partner(s) interested in collaborating** – Portfolio 2a scores well due to an existing long-term agreement between Valley Water and Palo Alto regarding source water supply for reuse. Portfolios 2b and 4 require a source water agreement with Sunnyvale, which is still under negotiation. Portfolios 1a through 1d rely on source water from South Bay Water Recycling (SBWR), which is contingent (in part) on addressing long-term potable water supply needs in North San José and Santa Clara. An agreement is not yet being discussed between SBWR and Valley Water.
2. **Ease of public health regulatory compliance** – The GWR portfolios (1a, 2a, 2b, 4) receive the highest score because these GWR portfolios have the easiest regulatory compliance path ahead with respect to pathogens, chemicals, source control, monitoring and control, retention and response time, and TMF capacity. All direct potable reuse (DPR) options performed lower than GWR portfolios on TMF capacity, as it could be challenging to fill operator staff positions. Portfolio 1b performed better than 1c and 1d with respect to chemicals, as its RWA supply benefits from passing through a WTP before water is sent to customers. Portfolio 1c receives the lowest score because it uses an existing pipeline (the Milpitas pipeline) to send water to Valley Water distribution systems: an existing pipeline is more challenging to monitor than a new pipeline (as included in Portfolio 1d).
3. **Ease of environmental discharge regulatory compliance** – Portfolio 1b, 1c, and 1d receive the highest score for environmental discharge as these have no environmental discharges under normal operating conditions (although each may be designed with an option for discharge to streams or to surface or groundwater reservoirs for maximum utilization). Portfolios 1a, 2a, 2b, and 4 receive moderate scores because these portfolios have no medium or dark blue boxes in Table 1-4 to indicate areas of concern regarding discharges.
4. **Design readiness** – Portfolio 1a receives the highest score for this sub-criterion due to the volume of study done by Valley Water's Expedited Purified Water Program Plan (Expedited Plan) on a GWR option using an AWPF located in San Jose. The Expedited Plan also examined a scenario similar to Portfolio 1b for RWA, although the detail is less than for the GWR scenario (i.e., Portfolio 1a). Portfolios 1c, 1d, 2a, 2b and 4 are new to this Master Plan and receive lower scores.
5. **Anticipated permit requirements** – Portfolio 2a receives the highest score based on having the fewest anticipated NEPA/CEQA permit requirements (it is the least likely portfolio to require a U.S. Fish and Wildlife Service (USFWS) Section 7 permit or a Cultural Resources permit).
6. **Public acceptance/support** – The public acceptance sub-criterion is based on the assumed difficulty in getting public buy-in on portfolio element designs and the location of new facilities.

More detailed polls of Santa Clara County residents are recommended to further inform this assumption. Portfolio 1a and 2a both receive high scores, as the AWPF technologies recommended are not new and could be justified to the public, and the proposed AWPF locations are likely to be supported by the public at large. It is assumed that the public would have the lowest support for TWA AWPFs in Portfolios 1c and 1d, followed by RWA AWPF, such as the treatment facility in Portfolio 1b. Portfolios 2b and 4 are scored moderately because there could be public push-back against the Recycle Hill or other Sunnyvale locations.

1.2.5 Engineering Feasibility

This criterion is made up of five sub-criteria:

1. **Need for pilot study** – Portfolio 1a, 2a, 2b, and 4 receive the high score because treatment technologies used would mirror technologies used at Silicon Valley Advanced Water Purification Center (SVAWPC) that are tested at scale and would not require a pilot study.
2. **Ease of pipeline construction** – Portfolio 1a scores highly for this sub-criterion because it avoids crowded utility corridors and high-traffic areas that are of concern for Portfolios 2a, 2b, and 2c. Portfolios 1b, 1c, and 1d are also expected to have challenges with crossings and high-traffic areas.
3. **Land acquisition/ownership** – Portfolios 1a through 1d and Portfolio 2b score highly for this sub-criterion because land is available in the area near the SJ/SC RWF and near the Sunnyvale Water Pollution Control Plant (WPCP). Portfolios 2a and 4 score lower because the site Palo Alto has identified for a potential regional AWPF requires voter approval for use of the land.
4. **Site preparation requirements** – Portfolios 1a through 1d and Portfolio 2a score highly for this sub-criterion because land identified for these projects would not require significant site work prior to construction. Portfolios 2b and 4 score lower because the site Sunnyvale has identified for a regional AWPF is a former landfill with unknown contaminants.
5. **Ease of Operation** – Portfolios 1a, 2a, 2b, and 4 score highly for this sub-criterion because Valley Water already has experience operating SVAWPC. Portfolios 1c and 1d are the least favored because operating a TWA facility offers new and unique challenges. Portfolio 1b receives moderate scores because a gGWR facility is not as difficult to operate as an RWA facility.

1.3 South County Reuse Options Evaluation

South County reuse scenarios considered include NPR from South County Regional Wastewater Authority (SCRWA) (for comparison only), Option 1: NPR+ via SBWR, Option 2: a Morgan Hill satellite WWTP and AWPF used for GWR at existing percolation ponds, and Option 3: a Morgan Hill satellite WWTP and AWPF used for SWA at Anderson Reservoir. These South County options can be combined with any portfolio and, therefore, are evaluated separately. Tables 1-8 and 1-9 illustrate a basic side-by-side comparison of how the NPR/NPR+ options and the GWR vs. SWA options perform with respect to the five criteria, with green shading indicating the more favorable. A qualitative discussion of the results follows.

Table 1-8. South County NPR Element Qualitative Comparison

Criteria	Reference: Morgan Hill NPR from SCRWA	Option 1: Morgan Hill NPR+ from SBWR
Economics		🟩
Groundwater management and Countywide (regional) supply reliability		🟩
Environmental impacts/benefits and sustainability		🟩
Ease of implementation and permitting/ regulatory considerations	🟩	
Engineering feasibility		🟩

Green shading = more favorable

Table 1-9. South County PR Element Qualitative Comparison

Criteria	Option 2: Morgan Hill GWR	Option 3: Morgan Hill SWA
Economics	🟩	
Groundwater management and Countywide (regional) supply reliability		🟩
Environmental impacts/benefits and sustainability		🟩
Ease of implementation and permitting/ regulatory considerations	🟩	
Engineering feasibility	🟩	

Green shading = more favorable

1.3.1 Economics

The cost of NPR/NPR+ in South County is similar to several other NPR/NPR+ expansion options in North County. Option 1: NPR+ from SBWR has a 30-year life-cycle unit cost of $2,200/AF. Although this study did not calculate a life-cycle unit cost for the NPR from SCRWA option, both capital and O&M costs are higher for the SCRWA option than for Option 1. Therefore, Option 1 scores higher than NPR from SCRWA for economics. As shown in Sections 3.2 and 4.1 of Appendix A-1, the 30-year and 100-year life-cycle costs for the South County PR elements are high relative to the supply yield: Option 2 has a 30-year life-cycle unit cost of $6,100/AF, and Option 3 has a 30-year life-cycle unit cost of $7,000/AF. Option 2 scores higher due to its lower relative cost, but both have higher unit costs than North County portfolios.

1.3.2 Groundwater Management and Countywide (Regional) Supply Reliability

South County projects provide moderate benefit for Countywide (regional) supply reliability. Although none of the projects makes a significant contribution toward Valley Water's reuse goals and supply would be highly seasonal, any NPR or PR water used in South County helps offset groundwater use, which provides groundwater management benefits and increased local supply reliability. Option 1 scores higher than NPR from SCRWA because connecting two otherwise hydrologically separate areas, North County and South County, with an NPR+ pipeline could have supply and drought reliability benefits. Option 2 is limited in the number of groundwater delivery points due to the density of potable wells in the area. Although Option 3 does not provide a direct groundwater recharge delivery point, it augments local surface water when supply is available and would be able to use that supply, at least in theory, to recharge the groundwater basin when needed. Option 3 performs similarly with respect to the groundwater management sub-criteria but has more delivery points than Option 2, and therefore receives a higher score.

1.3.3 Environmental Impacts/Benefits and Sustainability

Environmental impacts relating to CEQA/NEPA were evaluated for North County portfolios as part of the ROC Management study (Appendix G) but not for South County options; however, it is anticipated that the longer pipelines and greater elevation gain of the concept to pump NPR supply from SCRWA leads to greater energy use and more CEQA/NEPA impacts. Thus, it earns a lower score for this criterion than Option 1: NPR+ from SBWR.

The main difference between the two PR projects is also related to conveyance. Option 3 for SWA includes twice as long of a pipeline and ~560 feet of elevation gain (compared to ~48 feet for Option 2). Therefore, Option 2 scores higher for this criterion than Option 3.

1.3.4 Ease of Implementation and Permitting/Regulatory Considerations

Option 1, NPR+ from SBWR, performs less favorably compared to NPR from SCRWA in at least three areas:

1. Partnerships – SBWR, Valley Water, and Morgan Hill would need to reach agreement to terms of a supply agreement
2. Ownership of wastewater – San José would lose ownership when sending NPR+ supply to Morgan Hill
3. Operational simplicity – Adding another large supply area to SBWR's system could lead to operational challenges.

Public support, environmental justice issues, and permitting/compliance are not anticipated to differ greatly between the two options. Timing/readiness to proceed might give a slight advantage to Option 1 over NPR from SCRWA. Overall, for this criterion, NPR from SCRWA receives a higher score than Option 1.

For PR projects, Option 2 outperforms Option 3 due to operational simplicity and timing (readiness to proceed). Option 3 scores higher for public support than Option 2, as GWR would need to displace existing potable wells in order to perform GWR in Morgan Hill. Overall, Option 2 is still on top.

1.3.5 Engineering Feasibility

Although the PR sub-criteria used for the North County portfolio comparison are not relevant to the comparison of NPR options in Morgan Hill, Option 1 scores higher than the NPR option using SCRWA flows due to having less required transmission infrastructure.

For PR projects, Option 2 outperforms Option 3 due to its lower project complexity and established precedent (i.e., GWR is more common than SWA in California to date).

Section 2: Risk Assessment

Risks for each portfolio are assessed separately from the overall evaluation to provide a focused review of aspects that may disrupt, delay, or halt projects. This assessment considers each portfolio in context of risks within seven categories and compiles results in a risk matrix.

2.1 Risk Identification

For the purpose of this assessment, a risk is defined as an event or outcome that could stop, slow, or otherwise hinder the planning, design, and/or construction of projects pursued as part of Valley Water's Countywide Water Reuse Master Plan. The Master Plan aims to manage risks through early identification and assessment, including determining the potential for the risk to occur and related consequences, mitigation approach, safeguards, and/or alternatives. Risk tolerance is a term used in the financial sector to refer to an investor's willingness to accept loss. Similarly, Countywide reuse program partners have varying risk tolerances that may range depending on specific context, agency goals, and other variables. When establishing partnership agreements and selecting project elements to implement, an important early step will involve defining respective risk tolerances of Valley Water and participating Partner Agencies.

The Project Team identified risks within the following seven categories through input from water reuse subject matter experts, reuse industry guidance (such as Water Research Foundation's Reference Manual 4715; Water Research Foundation, 2019), and risks discussed during meetings between Valley Water and Partner Agencies.

1. Public support
    - Lack of understanding among public, leading to skepticism or opposition to potable reuse as a drinking water supply and/or associated rate increases
    - Public opposition to locations of new facilities
2. Partnership
    - Challenges in inter-agency coordination and collaboration related to project implementation (e.g., roles, responsibility, ownership)
    - Terms of new agreements for source water not reached
3. Regulatory/permitting
    - Ambiguity in requirements for DPR, including RWA and TWA, due to current lack of established regulations
    - Inability to permit from public health perspective (Division of Drinking Water [DDW] approval) for scenarios where regulations exist (i.e., NPR and indirect potable reuse [IPR]) or for DPR, once regulations are established
    - Lack of access to cost-effective management strategies for residual streams (i.e., RO concentrate)
    - Inability to permit discharges (e.g., ROC Management)
4. Operations
    - Lack of certified operators for advanced treatment (both short and long term)
    - Inconsistent facility flow/supply yield due to diurnal patterns, seasonal variations, and/or climatic conditions
    - Inability to use purified water to extent anticipated due to limitations of delivery points (e.g., groundwater basin conditions)
    - Challenge in coordinated operations for projects involving interconnected systems
5. Source water supply availability
    - Uncertainty in future WWTP effluent available for reuse (based on lower WWTP influent and/or higher NPR demands, environmental flows, or greater seasonality or diurnal variations in flow)
6. Funding

  - Inability to fund program; limited grant funding opportunities (including terms precluding potential private-public partnership from receiving public grant funds); lack of revenue certainty; and/or lack of agreement for cost sharing

7. Distribution system
  - Potential for water quality problems such as water chemistry changes due to introduction of PR supply and corrosion control issues, or cross-connection risks of NPR

2.2 Risk Analysis

The Project Team qualitatively analyzed risks related to each portfolio/option considering the likelihood and consequence(s) of a particular risk occurring and mitigation strategies that could eliminate the risk or reduce its impact. Figure 2-1 presents an example of portfolio/option performance with respect to risk likelihood on the horizontal axis and risk consequence on the vertical axis. Likelihood and consequence scores are combined for the risk categories such that each portfolio/option has a single risk likelihood and risk consequence score. Prior to finalizing results from the risk tool, the Project Team plans to get feedback from Valley Water and Partner Agencies on individual risk category scores for the portfolios and options.

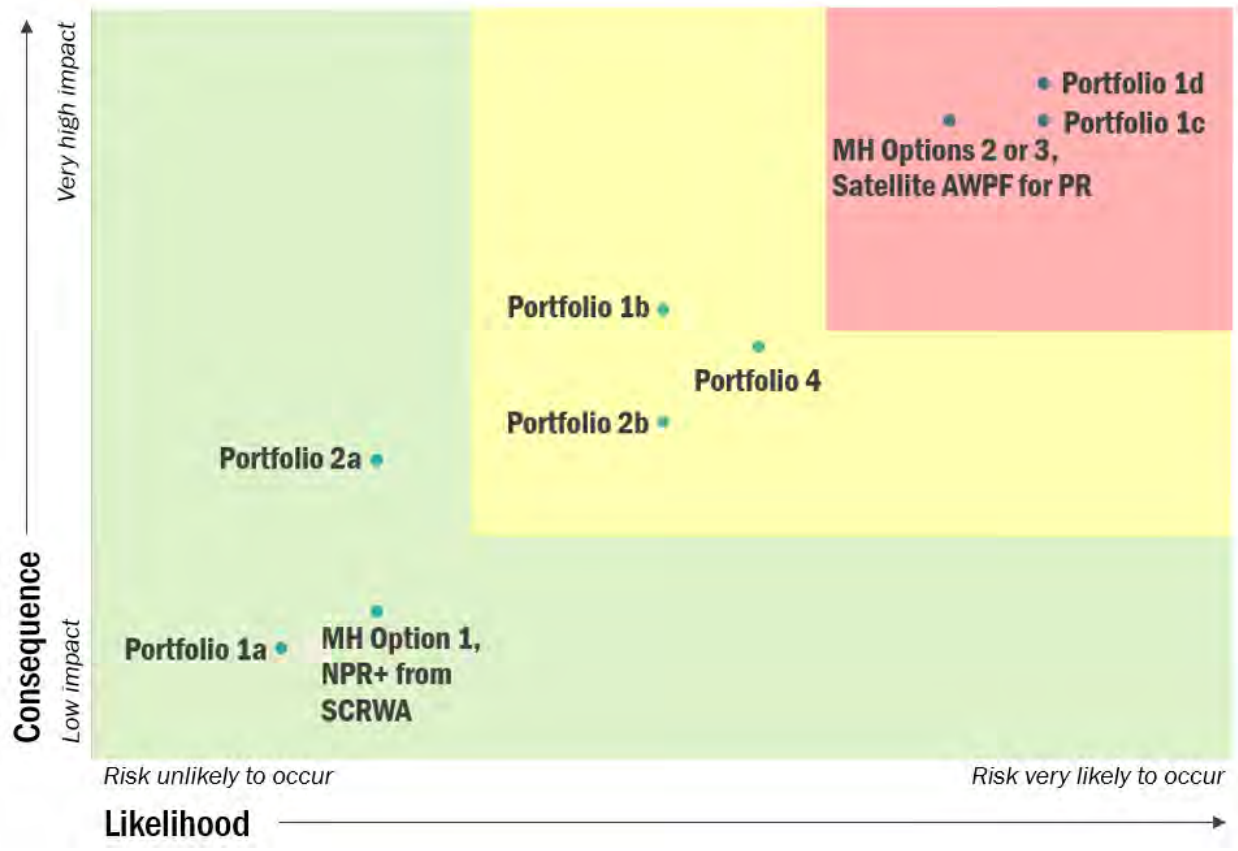

Figure 2-1. Example Risk Matrix comparison of portfolios and options indicating the likelihood of risk occurring on the x-axis and consequence of risk occurring on the y-axis

The Project Team also analyzed how portfolios/options compare using a qualitative risk score defined as the product of risk likelihood and risk consequence. Each score was then assigned a rating of low, medium, high and very high (Table 2-1).

Table 2-1. Risk Score Key [a]

	Rating	Scoring Factor	Consequence			
			Low Significance	Medium Significance	High Significance	Very High Significance
			1	2	3	4
Likelihood	Low	1	Low	Low	Medium	Medium
	Medium	2	Low	Medium	Medium	High
	High	3	Medium	Medium	High	High
	Very High	4	Medium	High	High	Very High

*a. Risk scores are the product of (consequence * likelihood) factors.*

🟥 = *Very High risk*
🟧 = *High risk*
🟨 = *Medium risk*
🟩 = *Low risk*

Example risk scores for each portfolio/option with respect to all individual risk categories are shown in Table 2-2. As stated above, the risk scoring requires input from Valley Water and Partner Agencies prior to finalization.

Table 2-2. Risk Matrix: Relative Comparison of Risks for North County Portfolios and South County Options

Category	Risk Description	Potential Consequences (Conditions/Events)	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4	Morgan Hill – Option 1	Morgan Hill- Options 2 or 3
1. Public support	Lack of public understanding, leading to skepticism or opposition to water reuse as a drinking water supply and/or associated rate increases	Potential to erode support from publicly elected decision makers, and ultimately slow or stop program/project construction	High	High	High	High	Medium	Medium	Medium	High	Medium
	Public opposition to location(s) of new facilities.		High	High	High	High	Low	Medium	Medium	Very High	High
2. Partnerships	Challenges in inter-agency coordination and collaboration related to project implementation (e.g., roles, responsibility, ownership)	Delayed or cancelled program/project construction due to not reaching agreement terms	Low	High	Very High	Very High	Low	Low	Low	Low	Low
	Terms of new agreements for source water not reached	Lower yield than planned for dry year supply reliability and/or delayed or cancelled program/project construction due to source water unavailability for planned reuse project(s)	Low	Medium	High	High	Medium	Medium	Medium	Low	High
3. Regulatory/permits	Ambiguity in DPR requirements, including RWA and TWA, due to current lack of established regulations	Increased project cost to meet requirements; delayed or cancelled program/project construction due to changes needed to details/design of project	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	High
	Inability to permit from public health perspective (DDW approval) for scenarios where regulations exist (i.e., NPR and IPR) or for DPR, once regulations are established		Medium	High	High	High	Medium	Medium	Medium	Low	High
	Lack of access to cost-effective management strategies for residual streams (i.e., ROC)		Medium	Medium	Medium	Medium	Medium	Medium	High	Low	Medium
	Inability to permit discharges (i.e., ROC Management)		Low	Low	Low	Low	Medium	Medium	Medium	Medium	High
4. Operations	Lack of certified operators for advanced treatment (over long term)	Delay in operating project(s), inability to realize anticipated yield for dry year reliability	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Medium
	Inconsistent facility flow/supply yield due to diurnal patterns, seasonal variations, and/or climatic conditions	Compromised reuse goals, underused assets, increased O&M costs and equipment problems	Low	Low	Low	Low	Medium	Medium	Medium	Medium	Low
	Inability to use recycled/purified water to extent anticipated due to limitations of delivery points (e.g., groundwater basin conditions)		Low	Low	Low	Low	High	High	High	Medium	High
	Challenge in coordinated operations for projects involving interconnected systems		Low	Medium	Low	Medium	Medium	Medium	Medium	Medium	High
5. Source water supply availability	Uncertainty in future WWTP effluent available for reuse	Compromised reuse goals, underused assets/ oversized facilities	Low	Medium	High	High	Low	Low	Low	Low	Medium
6. Funding	Inability to fund program; limited grant funding opportunities (including terms precluding potential private-public partnership from receiving public grant funds); lack of revenue certainty; and/or lack of agreement for cost sharing	Delayed or cancelled program/project construction; inability to recover costs	High	High	High	High	Medium	Medium	Medium	High	Medium
7. Distribution system issues	Water quality problems: (1) introducing new sources of potable supply may change water chemistry and potentially disrupt corrosion control (2) new NPR lines risk cross-connections	Public health risks, including exposure to contamination from: (1) lead (2) pathogens	High	High	High	High	Low	Medium	Medium	Very High	High

🟥 = *Very High risk*
🟧 = *High risk*
🟨 = *Medium risk*
🟩 = *Low risk*

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2.3 Risk Mitigation

Methods to manage risks are identified by risk category, as follows.

1. Public support
    - Collaborate with Partner Agencies to develop and implement a framework for consistent regional public outreach related to potable reuse
    - Build stakeholder support early in program planning process and engage champions
    - Increase use of SVAWPC as a tool to educate the public
    - Work with public figures and media outlets to inform messaging about PR
    - Collaborate to establish best practices for testing water quality within reuse distribution systems
    - Involve public and stakeholders early in planning process to keep local residents aware of planned facilities (particularly if located near residences, office buildings, and recreation areas) to avoid potential opposition when applying for permits
2. Partnership
    - Consider agreements that allow for integrated, holistic solutions
    - Establish effective communication and collaboration venues among agencies at technical, operational, and managerial levels
    - Consider interim agreements (e.g., incremental progress, shorter duration) if longer or more complex agreements are too hard to reach
    - Use third-party mediation and/or facilitation
3. Regulatory/permitting
    - Communicate early and often with regulators to determine permitting requirements for PR
    - Involve an Independent Advisory Panel to assess technologies and approaches to protect public health
    - Seek innovative technologies and permitting approaches to manage ROC quantity and quality
4. Operations
    - Support operators in obtaining advanced water treatment certification
    - Construct more storage and/or use groundwater banking to shield against lower flows
5. Source water supply
    - Identify trends pertaining to source water availability and NPR use, and identify factors and uncertainties influencing future projections
    - Construct more storage and/or use groundwater banking to shield against lower flows
    - Identify alternate sources of water supply if possible

6. Funding
   - Establish a contingency plan for funding in case primary funding source is compromised
   - Implement program by prioritizing projects and enabling modular construction to incrementally increase facility capacity (as possible) to stretch ratepayer funds to yield the maximum possible benefit and reduce likelihood of constructing underused assets
7. Distribution system
   - Perform tests to simulate new blended water conditions and impacts on pipes
   - Implement robust cross-connection prevention programs; enforce purple pipe, signage and labelling rules; and target public communication/ awareness campaigns to developers, plumbers, and others

Section 3: Key Findings and Next Steps

The evaluation and risk assessment come to similar conclusions. Portfolios 1a and 2a are most well-balanced and perform favorably in scoring based on prioritization criteria and risk categories. Portfolio 1b also performed well in the evaluation, consistently ranking in the top three of five North County portfolios across various weighting scenarios.

South County options were evaluated separately. As part of the risk analysis, NPR sourced from SBWR for distribution in Morgan Hill carries lower risk than a satellite treatment facility for potable reuse.

Next steps for the evaluation and risk analysis involve soliciting input from the PPG and addressing potential refinements in the Draft Final Master Plan.

Appendix A-8: Treated Water Augmentation Pre-Screening Analysis

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Valley Water

MEMORANDUM

FC 14 (08-21-19)

TO: Hossein Ashktorab, Ph.D.
Recycled and Purified Water Unit Manager

FROM: Zach Helsley, P.E.

SUBJECT: Treated Water Augmentation Pre-Screening Analysis

DATE: May 22, 2020

This memorandum summarizes conceptual cost estimates developed by staff of eight expanded Treated Water Augmentation (TWA) alternatives originally presented in the TWA Addendum to D7[1] (TWA Addendum).

OBJECTIVES

The objectives of this analysis were to:

1) expand on TWA concepts identified in the TWA Addendum developed by Brown and Caldwell (BC) for the Countywide Water Reuse Master Plan (CWRMP) and develop conceptual cost estimates for treatment facilities, conveyance, pumping, and reverse osmosis concentrate management; and,
2) develop a recommendation for preferred alternatives for in-depth engineering design and cost estimation as part of the CWRMP.

BACKGROUND

Valley Water has undertaken the development of a CWRMP to evaluate potential potable and non-potable water reuse projects in Santa Clara County. The CWRMP will provide a framework for collaborative decision making that will guide project selection to best increase the region's water supply reliability through water reuse.

Previous engineering evaluations and stakeholder engagement have focused on weighing potential groundwater augmentation and raw water augmentation alternatives using treated wastewater from the four wastewater treatment facilities in the county. In August 2019, the State Water Resources Control Board Division of Drinking Water (DDW) released the Second Edition of a *Proposed Framework for Regulating Direct Potable Reuse in California* (Framework). The Second Edition of the Framework outlined DDW's intent to develop regulations for both raw water augmentation and TWA in parallel. DDW indicated their intent to develop a single combined regulatory package by December 2023. With regulations for TWA forthcoming, the CWRMP has expanded its scope[2] of feasible projects to include evaluation of TWA opportunities in the county.

Based on input received May 20, 2019 from Valley Water's Recycled Water Committee, the CWRMP team developed several versions of draft TWA conceptual options which were summarized in the TWA Addendum. These draft options were shared with stakeholders for input during one-on-one meetings in December 2019 through February 2020 and during the Project Partner Group (PPG) meeting #6 on February 24, 2020. The PPG generally expressed positive interest to proceed with all TWA options for further analysis.

To assist in selecting up to three TWA options for further analysis, staff was directed to further refine the original five TWA concepts and prepare conceptual cost estimates.

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[1] *DRAFT Treated Water Augmentation (TWA) Addendum to D7*. Brown and Caldwell. February 19, 2020

[2] Amendment No. 2 to A4120A CAS File No. 4821 Countywide Water Reuse Master Plan. December 18, 2019

ASSUMPTIONS

In order to facilitate development of conceptual cost estimates for the expanded TWA concepts, several assumptions were made regarding requirements for blending with potable water, treatment processes, constructability, etc. General assumptions common to all TWA concepts are as follows (concept specific assumptions are detailed in following sections):

1. All alternatives assume that no blending of TWA water with other potable water sources will be required at the identified receptors.
2. Costs for right-of-way or real estate acquisitions were not included.
3. Costs associated with purchase or transfer of advanced water purification facility (AWPF) source water (i.e. treated wastewater) were not included.
4. The treatment process for proposed TWA AWPFs is assumed to be the same as the RWA AWPF described in the CWRMP Portfolio 1B[3], and will include tertiary treated wastewater, ozone-biologically active carbon, ultrafiltration, reverse osmosis, ultraviolet light – advanced oxidation, and chlorine disinfection. It is assumed that his configuration will comply with the forthcoming TWA regulations. The assumed TWA train adds an 8-hour clearwell to the RWA train. Since clearwell costs were not readily available, RWA costs were used in this screening.
5. No allowances have been made for additional storage or blending facilities at TWA receptors.
6. This analysis does not consider potential back-up/ alternative potable water sources, nor does it attempt to quantify the amount of TWA water that is delivered to existing treated water turnouts.
7. Pipeline alignments, AWPF treatment processes, need for purified water storage/blending structures are subject to revision by the CWRMP team as additional engineering analysis is complete. This additional analysis may change costs presented in this memorandum.

METHODOLOGY

First, the capital and annual operations and maintenance (O&M) costs for treatment, pipelines, pump stations, and reverse osmosis concentrate were estimated. Then, a simplified analysis of project lifecycle was conducted to compute estimated unit costs ($/AFY) for each concept.

Advanced Water Treatment Facilities

Costs for AWPFs were computed using a scaling factor derived from the capital and annual O&M costs for the 24 million gallon per day (MGD) AWPF in the CWRMP Portfolio 1B. The scaling factors can be found in Table 1. TWA AWPF costs were calculated by multiplying the scaling factor by the proposed capacity of the TWA AWPF. Costs for AWPFs proposed in Gilroy and Morgan Hill were estimated based on related engineering studies.

Table 1. Capital and O&M Scaling Factors

	24 MGD AWPF[a] ($M)	Scaling Factor ($M/MGD)
Capital Costs	369	15.38
Annual O&M	13.8	0.58

a. Source: *Deliverable 7 Feasible Project Portfolios Attachment D – Cost Estimates.* Table D-15 San José AWPF; 24 MGD for RWA (Portfolio 1b). Brown and Caldwell. February 19, 2020

Purified Water Pipelines

BC provided planning documentation for the purified water pipeline alignments developed for the TWA Addendum. As the original TWA concepts were refined, staff used Google Earth Pro and ESRI ArcGIS to develop purified water pipeline alignments for new scenarios and identify associated elevation changes and distances. Costs were developed using parametric costing factors used in the CWRMP[4]. New alignments, when required, were routed to follow major roadways and other public rights-of-way.

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[3] *Deliverable 7 Feasible Project Portfolios*. Section 2.1.3.3 Raw Water Augmentation. Brown and Caldwell. February 19, 2020

[4] *Deliverable 7 Feasible Project Portfolios Attachment C – Basis of Cost*. Table C-5 Conveyance Unit Cost Estimates Rate (%). Brown and Caldwell. February 19, 2020.

Trenchless construction was assumed when crossing large roadways, highways, railroad tracks, and creeks. Pipe sizes were chosen to keep fluid velocity below 5 feet per second.

Pump Stations

When pump stations were previously sized for similar flows as part of CWRMP D7, corresponding capital and annual O&M costs were used. For new pump stations, capital costs were computed using a scaling factor derived from the average capital costs and indicated horsepower for all pump stations develop in CWRMP D7. Horsepower requirements for new pump stations were estimated using the total hydraulic head based on the elevation difference at the start and end of the longest pipeline segment and frictional losses, an assumed 70% pump efficiency, and 90% motor efficiency. Annual O&M was calculated as 8% of the estimated capital cost.

RO Concentrate Management

RO concentrate management costs were adapted from the March 6, 2020 version of *Task 4 – Evaluation of ROC Management Options* Technical Memorandum. The primary management strategies for each respective AWPF location were used for this analysis. When new AWPFs were proposed, RO concentrate management strategies were resized using a power scaling factor with an R value of 0.6. Table 2 details the RO concentrate management strategies proposed for each site.

Table 2. RO Concentrate Management Strategies

AWPF Location	Primary Management Strategy[a]
Near San José-Santa Clara Regional Wastewater Facility	Discharge past Artesian Slough weir under a separate permit
Former Los Altos Treatment Plant (LATP)	Blend and discharge using existing outfall at Palo Alto Water Quality Control Plant (WQCP)
Near Sunnyvale Water Pollution Control Plant (WPCP)	Discharge to new shallow water outfall at Guadalupe Slough
City of Morgan Hill/ South County Regional Wastewater Authority (SCRWA)	Evaporation Ponds

a. *Task 4 – Evaluation of ROC Management Options*. Table 5.1 CAPEX and OPEX Estimates for ROC Management Options. GHD Inc. March 6, 2020

Lifecycle Assessment

Lifecycle costs and unit costs were calculated by scaling the replacement and renewal (R&R) costs for the Portfolio 1B by the ratio of the proposed TWA option total capital cost to the Portfolio 1B capital cost. Similar to Portfolio 1B, the long-term purified water yield was assumed to be 87% of production capacity. Construction was assumed to take four years and begin in 2024. Construction costs were distributed evenly over the four years. A real discount rate of 2.4% was used for present value calculations.

REFINED TWA CONCEPTS

Staff has explored and expanded the original five TWA conceptual options to include thirteen refined TWA options. Table 3 provides an overview of the refined TWA options.

Table 3. Overview of Refined TWA Options

Option No.	TWA Alternative	AWPF Location	AWPF Capacity (MGD)	TWA Receptor
1	TWA-1A	San José	24	Gibraltar Reservoir/ Intertie
				City of San José (North of 101)
				City of Santa Clara (North of 101)
2	TWA-1B			Gibraltar Reservoir/ Intertie
3	TWA-7A			Piedmont Valve Yard
				City of San José (North of 101)
				City of Santa Clara (North of 101)
4	TWA-7B			Piedmont Valve Yard
5	TWA-2	Former LATP	7	City of Palo Alto
				Miramonte Reservoir/ Valley Water
6	TWA-6A		24	Proposed West Pipeline extension
7	TWA-6A Alt			Proposed West Pipeline Extension Terminus – excluding cost of West Pipeline expansion
8	TWA-6B			Existing West Pipeline
9	TWA-3A	Sunnyvale	7	Serra Tanks via Wolf Rd.
10	TWA-3A Alt			Serra Tanks via Wolf Rd. with parallel purified water pipeline to San Lucar Pump Station
11	TWA-3B			City of Mountain View/ Miramonte Reservoir
12	TWA-4	Morgan Hill	1.25	City of Morgan Hill treated water distribution system
13	SWA-5[a]	SCRWA	3	Coyote Reservoir

a. SWA-5 is a surface water augmentation project

San José AWPF Options

TWA-1A – 24 MGD San José AWPF to San José/Santa Clara and Gibraltar Reservoir/ SFPUC Intertie

TWA-1A would treat available effluent from the San José-Santa Clara RWF at new AWPF near the RWF. The AWPF would produce up to 24 MGD of purified water and deliver the water to the North Side Storage Tanks to supply 4 MGD of purified water to the Cities of San José and Santa Clara. 20 MGD would be delivered to the Gibraltar Reservoir where it could be introduced to Valley Water's Milpitas Pipeline. Under normal operation, this water would flow south, and augment treated water supplies along the east side of the county. This option provides the opportunity to deliver purified water to the Gibraltar Reservoir/ intertie. RO concentrate would be discharged beyond the RWF's weir in Artesian Slough under a new NPDES permit.

TWA-1B – 24 MGD San José AWPF to Gibraltar Reservoir/ SFPUC Intertie

Similar to TWA-1A, TWA-1B would treat available effluent from the San José-Santa Clara RWF at a new AWPF near the RWF. All 24 MGD of purified water would be delivered to the Gibraltar Reservoir where it could be introduced to Valley Water's Milpitas Pipeline. Under normal operation, this water would flow south and augment treated water supplies along the east side of the county. This option also provides the opportunity to deliver purified water to the SFPUC/ Valley Water intertie. RO concentrate would be discharged beyond the RWF's weir in Artesian Slough under a new NPDES permit.

TWA-7A – 24 MGD San José AWPF to San José/Santa Clara and Piedmont Valve Yard
TWA-7A would treat available effluent from the San José-Santa Clara RWF at new AWPF near the RWF. The AWPF would produce up to 24 MGD of purified water and deliver the water to the North Side Storage Tanks to supply 4 MGD of purified water to the Cities of San José and Santa Clara. 20 MGD would be delivered to the Piedmont Valve Yard below Valley Water's Penitencia Water Treatment Plant. From the Piedmont Valve Yard, purified water could be introduced to the Milpitas Pipeline to augment treated water supplies along the east side of the county, and could be conveyed in the future through the Milpitas Intertie. Purified Water would also be conveyed south through the East Pipeline to existing treated water turnouts. If excess purified water is available, it could be introduced to Valley Water's Central Pipeline and used at the Los Gatos recharge ponds for groundwater augmentation or supplied to the Rinconada Water Treatment Plant via the Vasona Valve Yard. RO concentrate would be discharged beyond the RWF's weir in Artesian Slough under a new NPDES permit.

TWA-7B – 24 MGD San José AWPF to Piedmont Valve Yard
TWA-7B is identical to TWA-7A except that it excludes the 4 MGD of purified water being delivered to the Cities of San José and Santa Clara. All 24 MGD of purified water would be delivered to the Piedmont Valve Yard.

Former LATP Sites

TWA-2 – 7 MGD LATP AWPF to Cities of Palo Alto and Mountain View
TWA-2 is unchanged from the proposed TWA-2 identified in the TWA Addendum. TWA-2 would treat up to 7 MGD of available effluent from the Palo Alto WQCP at a new AWPF located at the former LATP site. 3 MGD of purified water would be delivered to the City of Palo Alto at a yet to be determined location. The remaining 4 MGD of purified water would be delivered to the City of Mountain View and Valley Water at the Graham Middle School Reservoir and Miramonte Reservoir. RO concentrate would be blended with any remaining treated wastewater and discharged using the existing outfall at the Palo Alto WQCP.

TWA-6A – 24 MGD LATP AWPF to Proposed West Pipeline Extension
TWA-6A considers treating up to 24 MGD of available wastewater from the Palo Alto WQCP and the Sunnyvale WPCP at a new AWPF at the former LATP site. Purified water would be delivered to the terminus of the proposed West Pipeline extension at the intersection of Page Mill Road and Foothill Expressway.

The proposed West Pipeline Extension is a water supply reliability project previously evaluated by Valley Water's Water Supply Planning Unit. The proposed project would extend the existing West Pipeline north along Foothill Expressway to intersect the San Francisco Public Utility Commission's (SFPUC) Bay Division Pipeline. A system intertie would be constructed to allow Valley Water treated water to be conveyed to the SFPUC system, or for Valley Water to receive SFPUC water at times when Valley Water treatment plants were unable to meet the county's water supply demands. The West Pipeline Extension in 2012 was estimated to cost approximately $252M[5]. This cost includes the pipeline extension of 5.6 miles of 42" diameter pipe, 9.3 miles of parallel pipe of various unspecified diameters from Granger Turnout to Rinconada Water Treatment Plant, and an intertie pump station.

Purified water introduced to the proposed West Pipeline extension would normally flow south along the West Pipeline and supplement drinking water supplies to existing turnouts. Under emergency situations, purified water could be conveyed through the new intertie to the SFPUC system. RO concentrate would be blended with any remaining treated wastewater and discharged using the existing outfall at the Palo Alto WQCP.

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[5] Erin Baker. Email to Angela Cheung. *WPL Extension & Intertie*. December 31, 2014

TWA-6A Alt – 24 MGD LATP AWPF to Proposed West Pipeline Extension
TWA-6A Alt is identical to TWA-6A, except the cost of the West Pipeline Extension project was excluded.

TWA-6B – 24 MGD LATP AWPF to Existing West Pipeline
TWA-6B considers treating up to 24 MGD of available wastewater from the Palo Alto WQCP and the Sunnyvale WPCP at a new AWPF at the former LATP site. Purified water would be delivered to Valley Water's existing West Pipeline. Delivery would occur at a location of comparable pipe diameter, approximately in the vicinity of Stevens Creek Blvd. and Imperial Ave. Purified water could then be conveyed north to existing turnouts on the West Pipeline, Sunnyvale Distributary, and Mountain View Distributary. Remaining purified water could be conveyed south to existing treated water turnouts on the West Pipeline. RO concentrate would be blended with any remaining treated wastewater and discharged using the existing outfall at the Palo Alto WQCP.

Sunnyvale AWPF Options

TWA-3A – 7 MGD Sunnyvale AWPF to City of Sunnyvale and Valley Water
TWA-3A would treat up to 7 MGD of available effluent from the Sunnyvale WPCP at a new AWPF near the WPCP. Two MGD of purified water would be delivered to the Serra Storage Tanks for use by the City of Sunnyvale and Valley Water. To minimize impacts to the Sunnyvale Recycled Water System, TWA-3A includes the construction of a new purified water pipeline from the AWPF to the existing Sunnyvale recycled water distribution system pipeline that brings water to the San Lucar Pump Station. This option assumes that this portion of the Sunnyvale Recycled Water System could be repurposed to convey purified water. Customers receiving water from this section of the existing recycled water system would receive purified water, however other customers of the Sunnyvale Recycled Water System would be unaffected. RO Concentrate would be discharged at a new shallow water outfall constructed in Guadalupe Slough where greater mixing and dilution could be achieved.

TWA-3A Alt – 7 MGD Sunnyvale AWPF to City of Sunnyvale and Valley Water
TWA-3A Alt is identical to TWA-3A except for a new purified water pipeline that would convey purified water parallel to the existing Sunnyvale Recycled Water System pipeline that brings water to the San Lucar Pump Station. The new parallel pipeline would allow purified water to be conveyed south to the Wolfe Road. Pipeline without impacting the Sunnyvale Recycled Water System. RO Concentrate would be discharged at a new shallow water outfall constructed in Guadalupe Slough where greater mixing and dilution could be achieved.

TWA-3B – 7 MGD Sunnyvale AWPF to Cities of Mountain View, Sunnyvale, and Valley Water
TWA-3B would treat up to 7 MGD of available effluent from the Sunnyvale WPCP at a new AWPF near the WPCP. A portion of the purified water would be delivered to the City of Sunnyvale at the Mary Avenue Tanks. Additional purified water would be delivered to the City of Mountain View at the Graham Middle School Reservoir and Miramonte Reservoir. Valley Water could use the remaining purified water at the Wright Ave Tanks or Miramonte Reservoir. Individual allocations of purified water between delivery points were not established for this analysis. RO Concentrate would be discharged at a new shallow water outfall constructed in Guadalupe Slough were greater mixing and dilution could be achieved.

Morgan Hill AWPF Options

TWA-4 – 1.25 MGD Satellite Morgan Hill AWPF to Morgan Hill Treated Water Distribution System
TWA-4 is unchanged from the proposed TWA-4 identified in the TWA Addendum. A satellite AWPF would be constructed in the City of Morgan Hill and would divert untreated wastewater from the sanitary sewer. Up to 1.25 MGD of purified water would be delivered to the existing treated water distribution system. RO concentrate would be conveyed to adjacent land to be evaporated.

SCRWA AWPF Options

SWA-5 – 3 MGD SCRWA AWPF to Coyote Reservoir

SWA-5 considers treating up to 3 MGD of available wastewater from SCRWA at a new AWPF located on adjacent SCRWA property. Purified water would be delivered to Valley Water's Coyote Reservoir for surface water augmentation. Currently water in Coyote Reservoir is captured rainfall from the Coyote River watershed. Water stored in the Coyote Reservoir is released to the Coyote River, where it will flow downstream to Valley Water's Anderson Reservoir. It is assumed that the combined volume and flow through Coyote and Anderson Reservoir would provide sufficient mixing and residence time to comply with existing surface water augmentation regulations. Water in Anderson Reservoir can be used to maintain stream flow in Coyote River or be conveyed through Valley Water's Cross Valley pipeline to Calero Reservoir and ultimately its three water treatment plants. RO concentrate would be conveyed to adjacent land currently owned by SCRWA to be evaporated.

RESULTS AND RECOMMENDATIONS

Results

Conceptual cost estimates for the refined TWA options are summarized in Table 4. A comparison of 30-year lifecycle costs is found in Table 5.

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Table 4. Summary of TWA Costs

AWPF Location	San José AWPF				Former LATP AWPF				Sunnyvale AWPF			Morgan Hill AWPF	SCRWA AWPF
TWA Alternative	**TWA-1A**	**TWA-1B**	**TWA-7A**	**TWA-7B**	**TWA-2**	**TWA-6A**	**TWA-6A Alt**	**TWA-6B**	**TWA-3A**	**TWA-3A alt**	**TWA-3B**	**TWA-4**	**SWA-5**
AWPF Capacity (MGD)	24	24	24	24	7	24	24	24	7	7	7	1.4	3
Long-term Yield (AFY)	23,400	23,400	23,400	23,400	6,821	23,400	23,400	23,400	6,821	6,821	6,821	1,218	2,923
Capital Cost ($M)													
Treatment	$370	$370	$370	$370	$108	$370	$370	$370	$119	$119	$119	$50	$70
Conveyance	$78.4	$54.1	$130.8	$104.5	$73.8	$475.5[a]	$165.5	$223.9	$18.5	$41.0	$69.2	$4.0	$49.0
Pump Stations	$3.8	$3.0	$15.9	$16.8	$10.5	$21.5	$21.5	$34.8	$4.1	$4.1	$5.4	$0.2	$6.4
ROCM	$28.7	$28.7	$28.7	$28.7	$13.9	$29.0	$29.0	$29.0	$20.6	$20.6	$20.6	$22.6	$45.1
Capital Total:	$480.9	$455.8	$545.4	$520.0	$206.2	$896.0	$586.0	$657.7	$162.2	$184.7	$214.2	$76.8	$170.5
Annual O&M ($M)													
Treatment	$13.8	$13.8	$13.8	$13.8	$4.1	$13.8	$13.8	$13.8	$4.1	$4.1	$4.1	$2.0	$2.1
Conveyance	$0.1	$0.1	$0.1	$0.1	$0.1	$0.2	$0.1	$0.2	$0.02	$0.05	$0.1	$0.01	$0.1
Pump Station	$0.3	$0.2	$1.3	$1.3	$0.8	$1.9	$1.9	$2.9	$0.3	$0.3	$0.4	$0.02	$0.5
ROCM	$0.36	$0.36	$0.36	$0.36	$0.17	$0.35	$0.35	$0.35	$0.27	$0.27	$0.27	$0.24	$0.48
Annual O&M Total:	$14.5	$14.4	$15.5	$15.6	$5.2	$16.2	$16.1	$17.3	$4.7	$4.8	$4.9	$2.3	$3.2
Life-Cycle Costs													
30-Year Life Cycle	$1,900	$1,800	$2,100	$2,000	$2,600	$3,000	$2,200	$2,400	$2,200	$2,400	$2,600	$5,800	$4,700
100-Year Life Cycle	$1,500	$1,500	$1,700	$1,600	$2,000	$2,300	$1,700	$1,900	$1,700	$1,900	$2,000	$4,500	$3,500

a. Includes $310M for West Pipeline Expansion project (escalated $252M from 2012$).

Table 5. 30-Year Life Cycle Costs (ordered lowest to highest)

Alternative	Description	Treatment Capacity (MGD)	Capital ($M)	Annual O&M ($M)	30-Year Life Cycle ($/AFY)
TWA-1B	SJ AWPF to Gibraltar Reservoir/ SFPUC Intertie	24	$455.8	$14.4	$1,800
TWA-1A	SJ AWPF to SJ/SC connection and Gibraltar Reservoir/ SFPUC Intertie	24	$480.9	$14.5	$1,900
TWA-7B	SJ AWPF to Piedmont Valve Yard	24	$520.0	$15.6	$2,000
TWA-7A	SJ AWPF to SJ/SC connection and Piedmont Valve Yard	24	$545.4	$15.5	$2,100
TWA-6A alt	LATP AWPF to proposed West Pipeline Extension Terminus – excluding cost of West Pipeline expansion	24	$586.0	$16.1	$2,200
TWA-3A	SU AWPF to Serra Tanks via Wolfe Rd.	7	$162.2	$4.7	$2,200
TWA-6B	LATP AWPF to existing West Pipeline	24	$657.7	$17.3	$2,400
TWA-3A alt	SU AWPF to Serra Tanks via Wolf Rd. with parallel purified water pipeline to San Lucar Pump Station	7	$184.7	$4.8	$2,400
TWA-3B	SU AWPF to City of Mountain View/ Miramonte Reservoir	7	$214.2	$4.9	$2,600
TWA-2	LATP AWPF to City of Mountain View and City of Palo Alto	7	$206.2	$5.2	$2,600
TWA-6A	LATP AWPF to proposed West Pipeline Extension	24	$896.0	$16.2	$3,000
SWA-5	SCRWA AWPF to Coyote Res.	3	$170.5	$3.2	$4,700
TWA-4	Morgan Hill AWPF	1.25	$76.8	$2.3	$5,800

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Recommendations

Staff has developed conceptual cost estimates for thirteen refined TWA alternatives to identify potential concepts for further engineering analysis. Evaluations were performed assuming wastewater was available, ROC management options were applicable, and TWA water could be applied at the identified receptors.

Identified TWA alternatives that deliver purified water to the East Pipeline, either at the Gibraltar Reservoir (TWA-1A and TWA-1B) or at the Piedmont Valve Yard (TWA-7A and TW-7B) were found to have the lowest life-cycle costs as a result of their ability to utilize large volumes of purified water and their lower conveyance requirements. These TWA alternatives include a number of ancillary operational benefits, including the ability to move water throughout the east side of the county, and the potential to convey purified water to the SFPUC system via the Milpitas Intertie. Therefore, staff recommends TWA-1A, TWA-1B, TWA-7A, and TWA-7B for additional engineering analysis and cost assessment as part of the CWRMP. Staff recommends these analysis should include the evaluation of actual demand and the ability of turnouts along the Milpitas and East Pipelines to utilize purified water in addition to existing treated water supplies, including refinements to purified water alignments and evaluation of storage and blending facility needs at TWA receptors.

Staff acknowledges ancillary benefits beyond conveying purified water could be realized if the proposed West Pipeline Extension assumed in TWA-6A and TWA-6A Alt was constructed, including greater operational flexibility for Valley Water's treated water conveyance and additional access to SFPUC's Bay Division Pipeline for improved reliability along the West Pipeline. Furthermore, if the construction cost to extend the West Pipeline is excluded from the alternatives analysis, the 30-year lifecycle cost is found to be competitive with the above recommended eastside alternatives. Since the proposed Westside Pipeline Extension project could have additional benefits beyond conveying potential purified water, staff recommends that further engineering and cost assessment be considered by management subject to available scope and task resources.

Respectfully,

Zachary Helley

Associate Engineer - Civil
Recycled and Purified Water Unit

cc: M. Silva, D. Tucker

LIST OF ATTACHMENTS

Attachment A – Figures of Refined TWA Options
Attachment B – Conceptual Cost Estimates

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Figure 1. TWA-1A/1B and TWA-7A/7B

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[redacted]

Figure 2. TWA-2

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[redacted]

Figure 3. TWA-3A/3B

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Figure 5. SWA-5

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Figure 6. TWA-6A/6B

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Table 6. Conceptual Cost Estimate Summary

Project Element	Location or Start Point	End Point	Diameter (in)	Flow Capacity (MGD)	Length (LF)	Long-Term Yield (AFY)	Total Capital Cost ($1,000s)	Annual O&M ($1,000s)
TWA-1A - Option Summary								
AWPF	San José	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	San José/Santa Clara RWF	San José AWPF	60	--	2,000	--	$6,400	$3
Purified Pipeline	San José AWPF	Northside Storage Tanks	24	--	23,810	--	$31,000	$39
Purified Pipeline	San José AWPF	Gibraltar Reservoir	36	--	20,722	--	$41,000	$34
Pump Station	San José AWPF	Northside Storage Tanks	--	--	--	--	$700	$56
Pump Station	San José AWPF	Gibraltar Reservoir	--	--	--	--	$3,100	$248
ROCM - Discharge beyond RWF Weir			--	--	--	--	$28,700	$362
						Total:	$480,900	$14,542
TWA-1B - Option Summary								
AWPF	San José	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	San José/Santa Clara RWF	San José AWPF	60	--	2,000	--	$6,400	$34
Purified Pipeline	San José AWPF	Gibraltar Reservoir	42	--	20,722	--	$47,700	$34
Pump Station	San José AWPF	Gibraltar Reservoir	--	--	--	--	$3,000	$240
ROCM - Discharge beyond RWF Weir			--	--	--	--	$28,700	$362
						Total:	$455,800	$14,470
TWA-2 - Option Summary								
AWPF	Former LATP	--	--	7	--	6,821	$108,000	$4,100
Effluent Pipeline	Palo Alto WQCP	Palo Alto AWPF	36	--	15,150	--	$29,400	$25
Purified Pipeline	Palo Alto AWPF	Bifurcation	20	--	7,064	--	$8,100	$12
Purified Pipeline	Bifurcation	Palo Alto TBD	12	--	11,259	--	$7,300	$19
Purified Pipeline	Bifurcation	Miramonte Reservoir	20	--	26,506	--	$29,000	$44
Pump Station	Palo Alto WQCP	Palo Alto AWPF	--	--	--	--	$4,420	$354
Pump Station	Palo Alto AWPF	Miramonte Reservoir	--	--	--	--	$6,100	$488
ROCM - Blend at existing outfall			--	--	--	--	$13,900	$170
						Total:	$206,220	$5,212
TWA-3A - Option Summary								
AWPF	Sunnyvale WPCP	--	--	7	--	6,821	$119,000	$4,100
Purified Pipeline	Sunnyvale AWPF	Existing SU RW Pipeline	24	--	3,950	--	$5,100	$7

Project Element	Location or Start Point	End Point	Diameter (in)	Flow Capacity (MGD)	Length (LF)	Long-Term Yield (AFY)	Total Capital Cost ($1,000s)	Annual O&M ($1,000s)
Purified Pipeline	Wolfe Rd. Pipeline	Serra Tanks	20	--	9,004	--	$11,700	$15
Purified Pipeline	Tie-in allowance (10%)	--	--	--	--	--	$1,680	--
Pump Station	Sunnyvale AWPF	Serra Tanks	--	--	--	--	$4,100	$168
ROCM - New shallow water outfall			--	--	--	--	$20,700	$270
						Total:	$162,280	$4,560
TWA-3A Alt - Option Summary								
AWPF	Sunnyvale WPCP	--	--	7	--	6,821	$119,000	$4,100
Purified Pipeline	Sunnyvale AWPF	Existing SU RW Pipeline	24	--	3,950	--	$5,100	$7
Purified Pipeline	Existing SU RW Pipeline	San Lucar Pump Station	24		15,619		$20,500	$26
Purified Pipeline	Wolfe Rd. Pipeline	Serra Tanks	24	--	9,004	--	$11,700	$15
Purified Pipeline	Tie-in allowance (10%)	--	--	--	--	--	$3,730	--
Pump Station	Sunnyvale AWPF	Serra Tanks	--	--	--	--	$4,100	$168
ROCM - New shallow water outfall			--	--	--	--	$20,700	$270
						Total:	$184,830	$4,586
TWA-3B - Option Summary								
AWPF	Sunnyvale WPCP	--	--	7	--	6,821	$119,000	$4,100
Purified Pipeline	Sunnyvale AWPF	Miramonte Reservoir	24	--	53,211	--	$69,200	$87
Pump Station	Sunnyvale AWPF	Miramonte Reservoir	--	--	--	--	$5,400	$432
ROCM - New shallow water outfall			--	--	--	--	$20,700	$270
						Total:	$214,300	$4,889
TWA-4 - Option Summary								
AWPF	Morgan Hill	--	--	1.25	--	1,218	$50,000	$2,000
Effluent Pipeline	Morgan Hill Sanitary Sewer	Morgan Hill AWPF	12	--	3,092	--	$2,000	$6
Purified Pipeline	Morgan Hill AWPF	Morgan Hill Potable System	12	--	3,092	--	$2,000	$6
Pump Station	Morgan Hill Sanitary Sewer	Morgan Hill AWPF	--	--	--	--	$100	$8
Pump Station	Morgan Hill AWPF	Morgan Hill Potable System					$100	$8
ROCM - Evaporation Ponds			--	--	--	--	$22,550	$240
						Total:	$76,750	$2,268
SWA-5 - Option Summary								

Project Element	**Location or Start Point**	**End Point**	**Diameter (in)**	**Flow Capacity (MGD)**	**Length (LF)**	**Long-Term Yield (AFY)**	**Total Capital Cost ($1,000s)**	**Annual O&M ($1,000s)**
AWPF	SCRWA	--	--	3	--	2,923	$70,000	$2,100
Purified Pipeline	SCRWA AWPF	Coyote Reservoir	16	--	55,660	--	$49,000	$91
Pump Station	SCRWA AWPF	Coyote Reservoir	--	--	--	--	$6,400	$512
ROCM - Evaporation Ponds			--	--	--	--	$45,100	$480
						Total:	$170,500	$3,183
TWA-6A - Option Summary								
AWPF	Former LATP	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	Palo Alto WQCP	Palo Alto AWPF	36	--	15,150	--	$29,400	$25
Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36		38,820		$74,100	$63
Purified Pipeline	Palo Alto AWPF	West Pipeline Extension	42		24,544		$62,000	$40
Purified Pipeline	West Pipeline Extension	--	Various	--	28,851	--	$310,000	$48
Pump Station	Palo Alto WQCP	Palo Alto AWPF	--	--	--	--	$4,420	$353
Pump Station	Sunnyvale AWPF	Palo Alto AWPF	--	--	--	--	$4,420	$501
Pump Station	Palo Alto AWPF	West Pipeline Extension					$12,700	$1,016
ROCM - Blend at existing outfall			--	--	--	--	$29,000	$348
						Total:	$896,040	$16,194
TWA-6A Alt - Option Summary								
AWPF	Former LATP	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	Palo Alto WQCP	Palo Alto AWPF	36	--	15,150	--	$29,400	$25
Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36		38,820		$74,100	$63
Purified Pipeline	Palo Alto AWPF	West Pipeline Extension	42		24,544		$62,000	$40
Pump Station	Palo Alto WQCP	Palo Alto AWPF	--	--	--	--	$4,420	$354
Pump Station	Sunnyvale AWPF	Palo Alto AWPF	--	--	--	--	$4,420	$501
Pump Station	Palo Alto AWPF	West Pipeline Extension					$12,700	$1,016
ROCM - Blend at existing outfall			--	--	--	--	$29,000	$348
						Total:	$586,040	$16,147
TWA-6B Option Summary								
AWPF	Former LATP	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	Palo Alto WQCP	Palo Alto AWPF	36	--	15,150	--	$29,400	$25
Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36		38,820		$74,100	$63

Project Element	Location or Start Point	End Point	Diameter (in)	Flow Capacity (MGD)	Length (LF)	Long-Term Yield (AFY)	Total Capital Cost ($1,000s)	Annual O&M ($1,000s)
Purified Pipeline	Palo Alto AWPF	Existing West Pipeline	42		52,844		$120,400	$87
Pump Station	Palo Alto WQCP	Palo Alto AWPF	--	--	--	--	$4,420	$354
Pump Station	Sunnyvale AWPF	Palo Alto AWPF	--	--	--	--	$4,420	$501
Pump Station	Palo Alto AWPF	West Pipeline Extension					$26,000	$2,080
ROCM - Blend at existing outfall			--	--	--	--	$29,000	$348
						Total:	$657,740	$17,258
TWA-7A - Option Summary								
AWPF	San José	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	San José/Santa Clara RWF	San José AWPF	60	--	2,000	--	$6,400	$3
Purified Pipeline	San José AWPF	Northside Storage Tanks	24	--	23,810	--	$31,000	$39
Purified Pipeline	San José AWPF	Piedmont Valve Yard	40	--	43,037	--	$93,400	$71
Pump Station	San José AWPF	Northside Storage Tanks	--	--	--	--	$700	$56
Pump Station	San José AWPF	Piedmont Valve Yard	--	--	--	--	$15,200	$1,216
ROCM - Discharge beyond RWF Weir			--	--	--	--	$28,700	$362
						Total:	$545,400	$15,547
TWA-7B - Option Summary								
AWPF	San José	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	San José/Santa Clara RWF	San José AWPF	60	--	2,000	--	$6,400	$3
Purified Pipeline	San José AWPF	Piedmont Valve Yard	42	--	43,037	--	$98,100	$71
Pump Station	San José AWPF	Piedmont Valve Yard	--	--	--	--	$16,800	$1,344
ROCM - Discharge beyond RWF Weir			--	--	--	--	$28,700	$362
						Total:	$520,000	$15,580

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Appendix B: Regulatory Compliance

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Appendix B-1: Regulatory Compliance Strategy TM

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Technical Memorandum

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC Internal)

Contract no.: A4120A

Appendix B1

Subject: Regulations and Regulatory Compliance

Date: June 12, 2020 (reissued June 30, 2020)

To: Miguel Silva, Valley Water Project Manager

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Limitations:

This document was prepared solely for Santa Clara Valley Water District (Valley Water) in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for the partners, regulatory agencies, and stakeholders contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 1: Introduction

This Technical Memorandum (TM) evaluates the reuse portfolios in terms of regulatory compliance to identify issues that might impact their feasibility or future permitting. This information can be used in conjunction with other analyses (e.g., cost and economic analyses, governance, siting, etc.) to obtain a global view of portfolio feasibility. The regulatory analysis has been structured to 1) highlight the key regulatory considerations applicable to each portfolio, 2) identify differences between portfolios in terms of regulatory challenges and 3) note efforts that are required or may assist with future regulatory and permitting efforts. The TM divides the regulatory considerations into those impacting public health and those associated with environmental compliance. Generally, the public health requirements are specified by the Division of Drinking Water (DDW) of the State Water Resources Control Board (State Board) while the environmental criteria are specified by the regional boards.

This TM begins with a summary of the existing regulatory criteria for indirect potable reuse (IPR) (Section 2) [1] followed by a more thorough analysis of considerations for direct potable reuse (DPR) (Section 3). This overview is important to define the criteria that will be used to evaluate the portfolios. A rubric (i.e., a framework used for evaluating the potable reuse portfolios based on various regulatory criteria) has been developed for each form of reuse to assess the relative difficulty or ease of complying with those criteria. Portfolios are ranked on a blue-coded scale—light, medium, and dark blue—to cover the range from less difficult (light blue) to more difficult (dark blue) in terms of regulatory compliance. The rubrics are then used to evaluate each portfolio included in the Master Plan:

- Groundwater recharge (GWR) (Section 4): GWR Portfolios 1a, 2a, 2b, and 4
- Surface water augmentation (SWA) (Section 5): SWA at Morgan Hill
- Raw water augmentation (RWA) (Section 6): RWA Portfolio 1b
- Treated water augmentation (TWA) (Section 6): TWA 1c and 1d at San José
- Non-potable reuse (NPR) (Section 7)

Section 8 concludes the TM with a summary and comparison of all the portfolios along with recommendations for next steps and future efforts to support regulatory and permitting efforts.

Regulations and Permits. This TM draws a distinction between the regulations that govern the various forms of reuse and the permits required to implement a project. The State Board develops water recycling requirements that are memorialized in regulations, such as Title 22 of the California Code of Regulations. These regulations specify the recycled water requirements for all types of reuse currently regulated in the state. Additionally, the State Board and other regulatory agencies throughout California and nationally develop regulations for the protection of the environment.

To uphold and enforce the regulations, the State Board and other agencies have defined the required permits and supporting documentation that must be approved for each project. These permits and regulatory deliverables take the form of documents such as National Pollutant Discharge Elimination System (NPDES) permits, water reuse requirements (WRR), waste discharge requirements (WDR), Title 22 Engineering Reports, and more. Because the required permits and documentation are similar across all types of water reuse, the portfolios will not be compared based on permit requirements. The TM focuses instead on regulatory compliance issues to allow for a comparison of each portfolio’s benefits and challenges. Figure 1-1 summarizes the regulations and required permits for each type of potable reuse. Additional discussion on the required documentation is presented in Appendix B2 – Regulatory Framework.

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[1] Previous deliverables for the Countywide Master Plan provide an in-depth discussion of the existing regulatory frameworks for non-potable reuse and IPR via both GWR and SWA (Appendix B2 – Regulatory Framework).

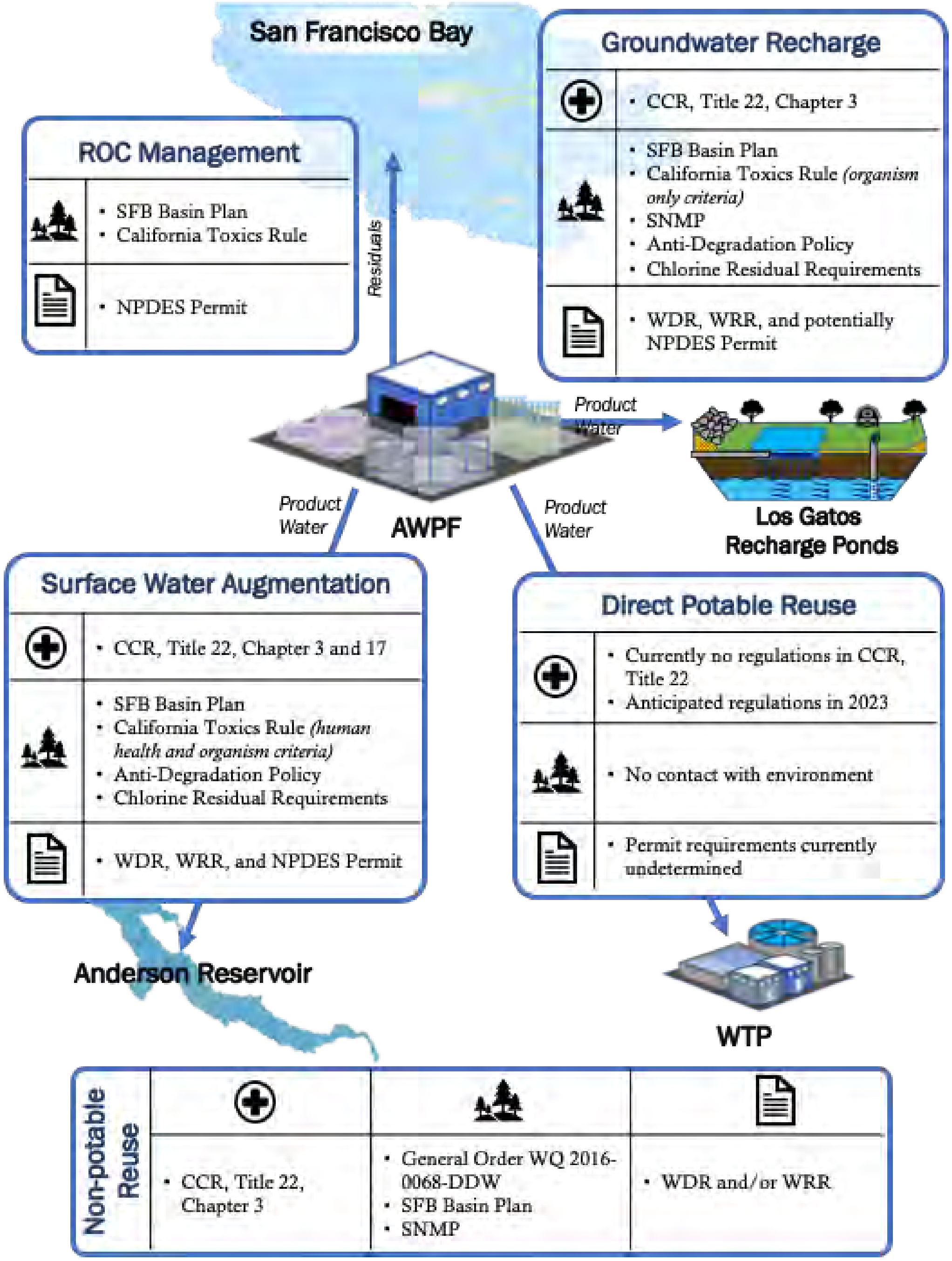
San Francisco Bay
ROC Management
SFB Basin Plan
California Toxics Rule
NPDES Permit
Residuals
Groundwater Recharge
CCR, Title 22, Chapter 3
SFB Basin Plan
California Toxics Rule (organism only criteria)
SNMP
Anti-Degradation Policy
Chlorine Residual Requirements
WDR, WRR, and potentially NPDES Permit
Product Water
Los Gatos Recharge Ponds
Product Water
AWPF
Product Water
Surface Water Augmentation
CCR, Title 22, Chapter 3 and 17
SFB Basin Plan
California Toxics Rule (human health and organism criteria)
Anti-Degradation Policy
Chlorine Residual Requirements
WDR, WRR, and NPDES Permit
Direct Potable Reuse
Currently no regulations in CCR, Title 22
Anticipated regulations in 2023
No contact with environment
Permit requirements currently undetermined
Anderson Reservoir
WTP
Non-potable Reuse
CCR, Title 22, Chapter 3
General Order WQ 2016-0068-DDW
SFB Basin Plan
SNMP
WDR and/or WRR

Figure 1-1. Summary of relevant regulations and required documentation for non-potable and potable reuse

Section 2: Indirect Potable Reuse Regulatory Overview

One benefit of pursuing an IPR project in California is that there is regulatory certainty in the form of final, adopted regulations for both GWR and SWA. Permitting IPR projects is more streamlined because these regulations provide clarity on the requirements for implementation. For GWR, there are also multiple precedents in the State, which has permitted eight projects, with the oldest in operation for nearly 60 years. Based on this experience, the regulatory community has significant first-hand knowledge of the challenges with GWR. Over the approximately 40-year period of GWR regulatory development (1976 to 2014), the State refined these requirements to adapt to its growing experience.

2.1 Public Health Criteria

A summary of the public health requirements for IPR via GWR and SWA is presented in Table 2-1. For additional in-depth discussion of the public health requirements for IPR, readers are directed to Appendix B2 – Regulatory Framework.

Table 2-1: Summary of Public Health Requirements for GWR and SWA

Potable Reuse Requirements	Groundwater Recharge	Surface Water Augmentation
Pathogen control	Log reduction value (LRV) requirements of 12/10/10 for virus/ *Giardia*/ *Cryptosporidium* (V/G/C) using a multiple-barrier approach	• 12/10/10 LRV with 100-to-1 dilution and theoretical retention time (TRT) > 120 days in the reservoir • 13/11/11 LRV with 10-to-1 dilution and TRT > 120 days • 14/12/12 LRV with 10-to-1 and 120 days > TRT > 60 days
Advanced Treatment Criteria	Full advanced treatment (FAT)—i.e., treatment of the full flow of water through reverse osmosis (RO) and an advanced oxidation process (AOP)—is required for GWR via subsurface injection and SWA. FAT is optional for spreading [a]	
Source Control	Must include: • Assessment of the fate of site-specific chemicals through the wastewater and recycled water treatment systems • Monitoring and investigation of chemical sources • Outreach program to manage and minimize the discharge of chemicals into the source water • Inventory of chemicals that may be discharged into the wastewater collection system.	
Chemical Control	In addition to Advanced Treatment Criteria, requires the monitoring of a suite of chemicals, including: • Regulated contaminants • Nitrogen compounds[b] • Unregulated contaminants, including priority toxic pollutants, site-specific unregulated chemicals, and constituents with numeric limits (NL).	
Recycled Water Contribution (RWC)	GWR projects using FAT require no diluent water by meeting the effluent total organic compound (TOC) limit of 0.5 milligrams/liter (mg/L).	N/A
Response retention time (GWR) Minimum TRT (SWA)	Minimum 2-month retention underground required. 10-log *Giardia* and *Cryptosporidium* credit for spreading projects providing ≥ 6 months of retention time. 1-log virus credit assigned for each month of retention time.	Reservoir must provide an initial minimum TRT of no less than 180 days. Alternative retention times allowed down to 60 days, though projects providing 60 to 120 days require additional pathogen control.

Table 2-1: Summary of Public Health Requirements for GWR and SWA

Potable Reuse Requirements	Groundwater Recharge	Surface Water Augmentation
Dilution	N/A	Water withdrawn from reservoir contains no more than either of the following: • 1% recycled municipal wastewater delivered to the reservoir during any 24-hour period • 10% recycled municipal wastewater delivered to the reservoir during any 24-hour period having been subjected to additional treatment producing no less than an additional 1-log reduction of V/G/C
Monitoring and Control	Includes: • Groundwater monitoring before and after advanced water purification facility (AWPF) product water delivery • Online monitoring at the AWPF to confirm LRVs • Monthly performance reporting to DDW • Quarterly and annual monitoring and reporting of product water and groundwater for various constituents	Includes: • Reservoir monitoring before and after AWPF product water delivery • Online monitoring at the AWPF to confirm LRVs • Monthly, quarterly, and annual monitoring and reporting of product water and reservoir water for various constituents
Technical, Managerial, Financial	Requirement that project sponsors demonstrate to DDW and Regional Board that they possess either a) adequate managerial and technical capability (GWR) or b) adequate financial, managerial, and technical capability (SWA) to assure compliance with all of the requirements	

a, Per Valley Water's 2017 decision, all GWR projects will use RO treatment (i.e., FAT) to ensure protection of the groundwater quality.

b. GWR requires additional nitrogen control beyond the MCLs to achieve a total nitrogen goal of 10 mg/L.

2.1.1 Evaluation Rubric for Groundwater Recharge

To facilitate a comparison of the potable reuse portfolios, the public health requirements have been grouped into six categories:

1. Pathogen control
2. Chemical control
3. Source control
4. Monitoring and control
5. Retention and response time
6. Technical, managerial, and financial (TMF) capacity

Each portfolio in the Master Plan is compared against these six public health criteria and scored based on its ability to meet the requirements for each specific form of potable reuse.

Using the regulatory requirements for groundwater recharge described above, a rubric has been developed to evaluate and score the portfolios (Table 2-2) The rubric simplifies each category in terms of color—light blue, medium blue, and dark blue—to indicate the relative ease or difficulty of permitting with regard to each of the key public health criteria. The same color coding applies to other forms of reuse described in subsequent sections. The color-coded rankings were developed based on multiple factors, including direction provided by a) the regulations themselves, b) experience from past, permitted projects, c) project team experience with current projects, and d) publications from the State Board. A general discussion of the rankings is presented below, with more detailed and portfolio-specific discussion provided in Section 4.1.

Table 2-2. Rubric for Evaluating Public Health Criteria in GWR Portfolios

	Pathogens	Chemicals	Source Control
	12/10/10 with ≥ 6 months or >12/10/10 with < 6 months	FAT	Source control program meets the enhanced requirements specified in IPR regulations
	12/10/10 with < 6 months	FAT + challenging source waters, or Non-FAT treatment	Challenging source waters or significant deviation from existing source control precedents
		Non-FAT treatment with challenging source waters	

	Monitoring and Control	Retention and Response Time	TMF Capacity
	Proven with many precedents Less stringent with longer retention times	≥ 6 months	Agencies with more AWPF experience and existing interagency agreements
	Requires coordinated monitoring and control of multiple AWPFs	2-6 months *with* compensation in treatment, monitoring, etc.	Agencies with less AWPF experience or lacking formalized interagency agreements
		2-6 months *without* compensation in treatment, monitoring, etc.	Agencies with less AWPF experience and lacking formalized interagency agreements

Pathogens. While the GWR regulations specify a minimum level of treatment of 12/10/10 for V/G/C, this may vary depending on the aquifer retention time available. DDW has stated that they consider an aquifer providing ≥6 months of retention time to be a significant environmental buffer. Based on the existing permitted GWR projects, providing ≥6 months of retention time and 12/10/10 allows for the most straightforward permitting, i.e., "light blue" ranking. As the retention time drops below 6 months, however, additional pathogen credits may be needed to compensate for a smaller environmental buffer (i.e., > 12/10/10). Projects seeking to provide the 12/10/10 minimum with less than 6 months of retention time may face more difficult permitting (i.e., "medium blue" ranking).

Chemicals. The existing IPR systems have demonstrated that the FAT train provides a high degree of protection against chemical constituents. A "medium blue" ranking was assigned for FAT trains only if there was uncertainty in the ability of the train to control chemicals, such as if there was significant industrial input with chemicals known to be less effectively removed by FAT. The "medium blue" ranking was also assigned for systems using a non-FAT alternative train. The "dark blue" ranking was assigned for non-FAT alternatives treating similarly difficult source waters.

Source control. There are multiple precedents for GWR source control programs that facilitate their permitting and implementation. A "light blue" ranking was assigned for most projects under the assumption that they would be enhanced to meet the source control requirements described in Table 2-1. "Medium blue" was assigned if there was a particularly challenging source water or any significant deviation from the existing precedents. There is not a statutory requirement in the Title 22 regulations to develop a formal agreement between the wastewater agency and the potable reuse agency (assuming they are different entities). While falling outside of the regulatory sphere, these agreements are beneficial to establish the roles and responsibilities of the partnering agencies, including the terms of the source control program.

Monitoring and control. The monitoring and control systems required for GWR projects are well understood based on the experience of the existing projects. While these systems provide continuous, on-line monitoring of many control points, they also benefit from the fact that water spends multiple months or years in the aquifer before extraction. The retention time provides a significant period to respond to failures, meaning that GWR monitoring and control does not need to be as stringent as potable reuse paradigms with much shorter retention times. The “medium blue” ranking was assigned to portfolios that have increased complexity, such as those that require the coordinated monitoring and control of multiple AWPFs (e.g., Portfolio 4).

Retention and response time. As discussed in the pathogens section above, projects providing ≥6 months of retention time fully leverage the benefits of the environmental barrier. DDW has stated that projects seeking <6 months should not automatically assume that their requests will be granted. Based on the reuse experience at locations like the Water Replenishment District and Padre Dam Municipal Water District (Padre Dam), gaining approval for projects providing less than two months requires significant additional interaction with DDW. These projects may also need to provide additional treatment or management barriers to compensate for the reduced benefits of the aquifer. Accordingly, “medium blue” is assigned for projects providing <6 months with some compensation and “dark blue” for those providing no compensation.

TMF capacity. DDW has not published the criteria that they use to determine a project sponsor’s TMF capacity. Consequently, assessments of TMF are not as easy to evaluate compared to the numerical criteria that DDW specifies for other topics, such as pathogen control. A “light blue” ranking was assigned for GWR portfolios that involve agencies with demonstrated experience in advanced treatment and potable reuse and have existing agreements between partner agencies establishing roles and responsibilities. For example, Orange County Water District (OCWD) and Orange County Sanitation District (OCSD) have a Joint Operating Agreement formalizing the terms of their partnership. Based on input from DDW, such agreements may be useful in demonstrating TMF capacity. “Medium blue” was assigned for projects involving agencies with less advanced treatment experience or for those where interagency agreements have not yet been formalized. “Dark blue” was assigned to projects with multiple “medium blue” factors present at the same time.

2.1.2 Evaluation Rubric for Surface Water Augmentation

Based on the regulatory requirements for SWA, the following rubric has been developed to evaluate and score SWA portfolios (Table 2-3).

Table 2-3. Rubric for evaluating public health criteria in SWA portfolios

	Pathogens	Chemicals	Source Control
	12/10/10 with 6 mos and 100:1 or 13/11/11 with 4-6 mos and 10:1	FAT	Source control program meets the enhanced requirements specified in IPR regulations
	14/12/12 with 2-4 mos and 10:1	FAT + challenging source waters, or Non-FAT treatment	Challenging source waters or significant deviation from existing source control precedents
		Non-FAT treatment with challenging source waters	

	Monitoring and Control	Retention and Response Time	TMF Capacity
	Single agency overseeing WW/AWTF and DW with > 100:1 dilution at a single end use location	> 120-d of theoretical retention time in the reservoir	Agencies with more AWPF experience and existing interagency agreements
	Mutiple agencies or multiple end uses or projects with < 100:1 dilution	< 120-d of theoretical retention time in the reservoir	Agencies with less AWPF experience or lacking formalized interagency agreements
	Multiple agencies with multiple end uses or with < 100:1 dilution		Agencies with less AWPF experience and lacking formalized interagency agreements

Like GWR, SWA projects benefit from the regulatory certainty of the 2018 SWA regulations. The regulations were developed, however, in a relatively short timeframe (approximately 2011 to 2016) meaning that they did not undergo the significant adaptation and refinement period of the GWR regulations. Furthermore, there are no SWA projects currently operating in the State. The pioneering projects (San Diego Pure Water Program and East County Advanced Water Purification Program) are providing important precedents by identifying the unique challenges of SWA. Through these two projects, DDW has gained better clarity on the important public health issues that must be dealt with during permitting.

As with GWR, the color-coded rankings were developed based on the same inputs: the SWA regulations, experience from projects pursuing SWA permits, and project team interaction with the State Board. A general discussion of the rankings is presented below with more detailed, portfolio-specific discussion provided in Section 5.1.

Pathogens. The SWA regulations provide clear guidance on the pathogen control requirements for projects providing >120 days of TRT in the reservoir: either 12/10/10 with 100:1 dilution or 13/11/11 for 10:1 dilution. The regulations introduce some vagueness for projects providing <120 days of retention time, stating that such projects will require “no less than one $\log_{10}$ reduction” of pathogens beyond the minimum requirements specified above. For example, the two SWA projects being pursued in San Diego County—the City of San Diego’s North City Pure Water project and the East County Advanced Water Purification (ECAWP) Program—fall on either side of the dilution and retention time: San Diego provides the minimum reservoir retention time (60 days) and dilution (10:1) while ECAWP provides longer retention times (>120 days) and higher dilution (100:1). San Diego's project, therefore, relies more heavily on engineered solutions to protect public health. This in turn leads to greater scrutiny by the State Board during project review and permitting. While both projects are feasible, the level of regulatory ease or difficulty may differ based on the project's specifics. Projects providing < 120 days are therefore assigned a "medium blue" ranking.

Chemicals. The same criteria used for the evaluation of chemical control in GWR are also applied for SWA.

Source control. The same criteria used for the evaluation of source control in GWR are also applied for SWA.

Monitoring and control. While the monitoring and control systems may be similar to GWR, SWA requires greater coordination due to the presence of both an AWPF and a surface water treatment plant (WTP). This coordination must be formalized in a Joint Plan that describes corrective actions to take in the event of water quality issues, and specifies the requirements for communication among the water recycling agency, the potable water provider, and the State and regional boards during such events. This plan must be reviewed and approved by both the State and regional boards. Portfolios were given a "light blue" ranking if they a) minimized complexity by having both the AWPF and WTP under a single agency, b) provided a more significant environmental barrier with > 100:1 dilution, and c) used the augmented reservoir water at a single end-use location. "Medium blue" was assigned to projects meeting all but one of these criteria, and "dark blue" to those diverging from these criteria in multiple aspects.

Retention and response time. Like with GWR, DDW requires a greater degree of interaction for projects providing less than a minimum degree of retention time. In the SWA regulations, the value that triggers additional oversight is 120 days; at this point, DDW begins to assess the project's requirements on a case-by-case basis (see discussion on pathogens above). Consequently, a "light blue" ranking is assigned to projects providing >120 days and "medium blue" to those providing <120 days.

TMF capacity. As with GWR, a "light blue" ranking was assigned for SWA portfolios that involve agencies with demonstrated experience in advanced treatment and potable reuse and have existing agreements between partner agencies establishing roles and responsibilities. "Medium blue" was assigned for projects involving agencies with less advanced treatment experience or for those where interagency agreements have not yet been formalized. "Dark blue" was assigned to projects with multiple "medium blue" factors present at the same time.

2.2 Environmental Compliance Criteria

Each portfolio has various environmental compliance criteria that must be met, but the anticipated level of complexity for compliance varies across portfolios. In each case, both a reverse osmosis concentrate (ROC) and AWPF product water will be produced. ROC will be discharged to the environment in every portfolio and must be done so in accordance with applicable regulations. For all of the IPR portfolios, the AWPF product water will pass through an environmental buffer that must also comply with environmental regulations. The DPR portfolios in the Master Plan do not release purified water to the environment and so only need to consider ROC discharge requirements.

To assess the relative ease or complexity of environmental compliance, each portfolio was evaluated on ROC management and AWPF product water releases. Within each category, there are environmental requirements defined in various regulations. Table 2-4 provides a summary of the environmental requirements for each type of discharge. Note that this is not a complete list of the environmental regulations that may be applicable to the portfolios. Other considerations, such as California Environmental Quality Act (CEQA) compliance, review and approvals from the California Department of Fish and Wildlife and from the San Francisco Bay Conservation and Development Commission, etc., will be important during later phases of project development. The environmental regulations included in Table 2-4 were selected because they define the water quality requirements for the discharges, and are therefore likely to have the largest impact on potential design elements of the portfolios.

Ultimately, the selected portfolio will require a number of permits to ensure compliance with these regulations. Purified water released to waters of the United States require NPDES permits, and so would future ROC discharges. Discharges to waters of California require WDR/WRR permits, and so future product water releases will likely include these permitting efforts for the GWR, SWA, and certain DPR portfolios (if an environmental buffer is used). It is possible that some product water releases will also require NPDES permits, which will be up to the discretion of the Regional Board. WDR/WRR and NPDES permits are administered by the Regional Board to ensure compliance with all applicable environmental regulations. As discussed, the present evaluation is focused on the regulations because it is assumed that the necessary permits would be obtained so long as all applicable regulatory requirements are met.

Table 2-4. Summary of Environmental Compliance Requirements for GWR and SWA

Environmental Regulation	Groundwater Recharge	Surface Water Augmentation
RO Concentrate Management		
San Francisco (SF) Bay Basin Plan	Narrative and numeric Surface Water Quality Objectives for discharges to the Artesian Slough (San José-Santa Clara Regional Wastewater Facility [SJ/SC RWF]), South San Francisco Bay and Matadero Creek (Palo Alto RWQCP), and Moffett Channel (Sunnyvale WPCP). Narrative objectives include bioaccumulation, biostimulatory substances, color, floating material, oil and grease, population and community ecology, radioactivity, toxicity, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, and temperature. Numeric objectives include: • Bacteria • Dissolved oxygen • pH • Turbidity • Un-ionized ammonia • Chemical constituents	
California Toxics Rule	Numeric objectives applicable to the SF Bay for the priority toxic pollutants described in the CTR 131.38 (b)(1), Table Columns B1, B2, and D2. These objective are applicable to all surface waters in California with defined beneficial uses that do not include municipal and domestic supply (MUN).	
Product Water Release		
SF Bay Basin Plan	Narrative and numeric surface water and groundwater quality objectives for product water delivered to the Los Gatos Recharge Ponds (LGRP) and Santa Clara Subbasin. Narrative objectives include bioaccumulation, biostimulatory substances, color, floating material, oil and grease, population and community ecology, toxicity, radioactivity, salinity, sediment, settleable material, suspended material, sulfide, and tastes and odors. Numeric objectives include: • Bacteria • Dissolved oxygen • pH • Turbidity • Temperature • Un-ionized ammonia • Additional chemical constituents	Narrative and numeric surface water quality objectives for product water delivered to Anderson Reservoir. Narrative objectives include bioaccumulation, biostimulatory substances, color, floating material, oil and grease, population and community ecology, toxicity, salinity, sediment, settleable material, suspended material, sulfide, and tastes and odors. Numeric objectives include: • Bacteria • Dissolved oxygen • pH • Radioactivity • Turbidity • Temperature • Un-ionized ammonia • Additional chemical constituents including maximum contaminant levels (MCL) and secondary maximum contaminant levels (sMCL)

Table 2-4. Summary of Environmental Compliance Requirements for GWR and SWA

Environmental Regulation	Groundwater Recharge	Surface Water Augmentation
California Toxics Rule	Numeric objectives applicable to the LGRP for the priority toxic pollutants described in the CTR 131.38 (b)(1), Table Columns B1, B2, and D2. These objectives are applicable to all surface waters in California with defined beneficial uses that do not include MUN.	Numeric objectives applicable to Anderson Reservoir for the priority toxic pollutants described in the CTR 131.38 (b)(1), Table Columns B1, B2, and D1. These objectives are applicable to all surface waters in California with defined beneficial uses that do include MUN.
Salt and Nutrient Management Plan	Numeric groundwater quality objectives that align with the SF Bay Basin Plan for total dissolved solids (TDS), nitrate (as NO_3), and nitrate plus nitrite (as N)	N/A
Anti-Degradation Policy	The existing high quality of LGRP and Anderson Reservoir must be maintained per State Board Resolution 68-16[2]	
Chlorine Residual Requirements	The EPA has established national criteria[3] for chlorine residual concentrations to protect freshwater aquatic life, including: • criterion maximum concentration (CMC) (1-hour) value of 19 micrograms per liter (µg/L) • criterion continuous concentration (CCC) (4-day) value of 11 µg/L	

Valley Water is leading an ROC management analysis that assesses strategies for each IPR portfolio, including GWR Portfolios 1a, 2a, 2b, and 4 as well as an SWA project at Morgan Hill. The four GWR projects will produce ROC that will be discharged to the SF Bay, whereas the SWA project at Morgan Hill requires an alternative ROC management strategy. For all potential projects, the requirements described in the SF Bay Basin Plan should be met.

This section will be updated when the ROC management approaches have been finalized.

This document also assesses AWPF product water compliance for all portfolios that include the use of environmental buffers, including Portfolios 1a, 2a, 2b, 4, and SWA at Morgan Hill. Similar to ROC discharge, all product water releases must comply with the SF Bay Basin Plan. Additional regulations may also apply, depending on the planned receiving water type and location, such as the California Toxics Rule (CTR), Salt and Nutrient Management Plans (SNMP), the Anti-Degradation Policy, and chlorine residual requirements. All of the relevant environmental regulations were introduced and summarized in Appendix B2 – Regulatory Framework. This document further describes regulations that specifically relate to each portfolio and assesses the complexity of complying with the regulation.

The following subsections introduce the considerations for assessing relative complexity of environmental regulatory compliance relevant to GWR and SWA projects. Each portfolio is ranked and scored based on AWPF product water considerations for GWR (Section 4.2) and SWA (Section 5.2).

2.2.1 Evaluation of Groundwater Recharge Portfolios for Environmental Compliance

The ROC management strategies for the GWR portfolios include eventual discharge to South SF Bay, though the mechanism of discharging ROC varies depending on the portfolio. Each ROC management approach comes with complexity and challenges, with some portfolios having more potential challenges than others. There are a number of considerations that can impact the complexity of a ROC permitting effort, including:

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[2] Resolution 68-16, Statement of Policy with Respect to Maintaining High Quality Waters in California was adopted by the State Board on October 28, 1968. California's 1968 antidegradation policy predates the creation of the U.S. Environmental Protection Agency, the 1972 federal Clean Water Act, and the implementation of the federal NPDES permit program.

[3] U.S. Environmental Protection Agency (EPA). National Recommended Water Quality Criteria. Located online at the EPA website at: water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm. Updated 2014.

- How many agencies will be responsible for monitoring and compliance with the discharge permit?
- Can an existing waste discharge outfall be used, or will a new outfall need to be constructed?
- Are all applicable water quality objectives met or will an innovative permitting strategy be required?
- Will multiple ROC discharge permits be needed (e.g., are multiple ROC discharge locations used)?
- Are there rare or endangered species with habitat that could be impacted by the ROC discharge?

The ROC management approaches developed by GHD will be compared for all of the GWR portfolios, organized by how the strategy will comply with the requirements of each applicable environmental regulation. **The section on ROC discharge compliance will be updated when the ROC management approaches have been finalized.**

On the AWPF product water release side, additional environmental regulations apply. All of the GWR portfolios involve the release of product water to LGRP that will eventually percolate into the Santa Clara Groundwater Subbasin. The relative complexity of environmental regulatory compliance is, therefore, similar across the GWR portfolios. There are differences in complexity, however, when comparing the GWR portfolios to the option for SWA at Morgan Hill, where the product water is sent to Anderson Reservoir. Considerations that can impact the complexity of releasing product water into the environment include:

- What is the mode of contact between the AWPF product water and the environment (e.g., surface spreading, groundwater injection, reservoir augmentation)?
- What beneficial uses and associated water quality objectives are applicable for the release location?
- Are product water releases from multiple AWPFs being sent to the same location?
- How many agencies will be responsible for monitoring and compliance with the discharge permit?

2.2.2 Evaluation of Surface Water Augmentation Portfolios for Environmental Compliance

A similar approach was used to rate and score the complexity of environmental regulatory compliance for the SWA portfolio as for the GWR portfolios.

For the product water release, the same considerations that impact relative complexity of compliance are applicable to the SWA portfolio. Similar environmental regulations apply with key distinctions, including the fact that Anderson Reservoir is currently used as a drinking water source and that significant percolation into the Santa Clara Subbasin is not expected. **The section on ROC discharge compliance will be updated when the ROC management approaches have been finalized.**

Section 3: DPR Regulatory Considerations

3.1 Overview

The key difference between IPR and DPR schemes is the elimination or reduction of the environmental buffer. This distinction is important because DPR schemes will not be able to rely on the environment to improve water quality or provide response time to address issues in water quality. A more immediate connection between treatment and consumption presents unique challenges for DPR. The challenges impact how DPR systems adapt to multiple issues: 1) pathogen control, 2) chemical control, 3) aesthetics, 4) failures, and 5) TMF capacity. The goal of the following sections is to provide perspective for why these are important issues for DPR, describe potential pathways for addressing them in the Master Plan portfolios, and develop criteria with which to evaluate the RWA and TWA portfolios.

3.2 Pathogen Control

Pathogens present a unique public health challenge because even a short-term failure to control their concentrations can result in infection and illness[4]. Pathogen control must, therefore, be consistent and reliable to protect the public. In IPR, treatment is balanced with other elements that protect public health, most notably the environmental buffer that provides both additional treatment and time to respond to failures. As this element decreases, the system may need to be rebalanced to rely more heavily on other elements for public health protection. The State Board recently identified treatment as an element that will be enhanced in DPR settings:

> The loss of the benefits of the environmental buffer must be offset with equally effective and reliable engineered treatment proximate to the drinking water user. (SWRCB 2019b)

The consequence of this rebalancing will likely be greater redundancy in pathogen control beyond what has been required for IPR:

> To minimize the chance that [log removal values] LRVs necessary to meet the health objective are not consistently met, DPR projects must provide log reduction capacity in excess of the basic LRVs (redundant LRV treatment). (SWRCB 2019b)

Insight into the potential future DPR LRV requirements can be gained by evaluating the pathogen control requirements in IPR. As IPR projects move from large to small environmental buffers, higher degrees of pathogen control are required. This is most clearly codified in the SWA regulations that require an additional 1-log reduction for projects with shorter retention times (i.e., less than 4 months) and lower degrees of dilution (i.e., less than 100:1). The combination of both of these conditions leads to an additional 2-log requirement above the base 12/10/10 LRVs. For example, the permit for San Diego's North City Pure Water Project requires minimum LRVs of 14/12/12 due to the fact that the Miramar Reservoir provides only a 2-month retention time with a 10:1 dilution. Based on these precedents, the State Board may require DPR systems to provide LRVs in excess of the 14/12/12 requirements for SWA.

To help with regulatory development, the State is actively investigating the relationship between treatment and risk as a part of their first priority DPR research project, DPR-1 (Pecson 2019). Risk is an important concept because previous drinking water and potable reuse regulations have established treatment goals based on meeting acceptably low levels of risk. One way that the State may ensure greater consistency of treatment performance is to shift from an annual risk goal to a daily risk goal. By looking at compliance on a shorter timescale, individual days with poorer performance and higher risk cannot be buffered out by other days with higher performance. This shift may be one of the means by which they justify the increase in pathogen removal requirements for DPR.

> Rather than allow water microbial quality and risk of infection to fluctuate significantly and meet the risk objective on an annual average, the treatment scheme is expected to be regulated to provide consistently safe water by imposing a daily risk objective that would not exceed 2.7×10^{-7} per day. (SWRCB 2019b)

The outcomes of the DPR research are not expected until 2020, and the State will also likely convene an Expert Panel to assist with the review of the future DPR regulations. As a result, greater clarity on the specific values may not be available until closer to the 2023 regulatory deadline. For the purposes of this TM, it is assumed that the pathogen requirements for DPR will be no less than 15/13/13 for both RWA and TWA. DDW stated during the June 9, 2020 meeting, at which members of the Project Team met with DDW to solicit feedback on the proposed Master Plan, that they do not have additional clarity on the future pathogen control requirements, but that 15/13/13 appeared to be a reasonable estimate that accounts for their stated concerns.

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[4] Most toxic chemicals of concern are present at sufficiently low levels in treated wastewater that they would require repeated, chronic, long-term exposure to lead to a significant public health impact.

Given these targets, it is unlikely that the FAT train alone will be sufficient to meet the future pathogen requirements, even with an additional free chlorine disinfection step (Table 3-1). An additional barrier or barriers may be needed to meet the DPR pathogen LRVs. Ideally, the additional barriers selected for pathogen control should also help meet the requirements for other DPR criteria, including chemical control and aesthetics. These topics are covered in the following sections.

Table 3-1. Typical Log Removal Credits of a FAT Train Compared to Potential DPR Log Reduction Requirements

Unit Processes	Microbiological Log Removal Credits		
	Viruses	*Giardia*	*Cryptosporidium*
Secondary effluent	0	0	0
Microfiltration/Ultrafiltration (MF/UF)	0	4	4
RO	2	2	2
Ultraviolet (UV)/AOP	6	6	6
Free chlorine	6	1	0
Total	**14**	**13**	**12**
Target DPR Requirements	**15**	**13**	**13**

3.2.1 Treatment

The most obvious approach to control pathogen concentrations is through treatment, and the State Board is open to crediting any of the treatment processes in the DPR system, including the wastewater treatment plant (WWTP), the AWPF, and the drinking water treatment plant (WTP).

Wastewater Treatment. The role of the WWTP has shifted in the context of potable reuse. Whereas it has historically sought to make waters suitable for environmental discharge, it is now viewed as the first and critical barrier to creating a high-quality and consistent feedwater for the AWPF (Olivieri et al. 2016, Tchobanoglous et al. 2015). The State Expert Panel recommended that wastewater treatment facilities feeding DPR AWPFs provide both biological nutrient removal and tertiary filtration (Olivieri et al. 2016). Improvements to water quality may:

- provide greater degrees of pathogen reduction or inactivation
- decrease the concentration of organic compounds and constituents of emerging concern (CECs)
- improve the performance of downstream processes

The State Board previously awarded pathogen credits to WWTPs using performance values from the literature, though they have indicated that they will greatly reduce the default credits using this approach. Higher reduction credits can be sought if agencies perform site-specific monitoring studies. Given the expectation of higher pathogen LRV requirements for DPR, multiple agencies are currently pursuing pathogen studies to quantify and seek credit for pathogen removal through the wastewater treatment plant (Pecson 2018). As part of the State's DPR research effort, they have also developed consistent standard operating procedures (SOPs) for the collection and analysis of wastewater pathogen data (Pecson 2019).

Advanced Water Treatment. Many AWPF unit processes have established pathogen crediting frameworks that allow for V/G/C credits through both removal (e.g., membrane filters) and disinfection processes (e.g., chlorine, UV, and ozone). Importantly, these frameworks use the online monitoring of performance surrogates to ensure the continuous, high performance of the processes. The State Board has indicated that this high degree of monitoring will be critical for assessing the performance of treatment barriers in DPR settings.

Drinking Water Treatment. RWA projects include the WTP as an additional barrier downstream of the AWPF. While WTPs are typically designed to meet the 4/3/2 requirements of the Surface Water Treatment Rules, the State Board has indicated that project sponsors should not expect to receive those credits by default. This departure stems from the fact that they will require the WTP to be subject to the same rigorous crediting schemes that are used for AWPF crediting. Currently, many of the conventional physical removal processes—such as flocculation/sedimentation and granular media filtration—do not have such established frameworks. Those processes that do—including disinfection and membrane filtration—should be more straightforward for crediting. However, it is not clear at this time if differing WTP credits will be given to the same WTP if or when using a lower influent-purified-water-to-raw-surface-water ratio than when using a higher influent-purified-water-to-raw-surface-water ratio.

3.2.2 Engineered Storage Buffers

The passage of treated effluent through a tank or another engineered storage buffer (ESB) provides an opportunity to a) mix the effluent with a larger volume of water and b) retain it for a period before releasing it into the downstream distribution system. **Mixing** can provide public health benefits during periods of off-spec water production or failure if the pulse of off-spec water combines with a larger volume of on-spec water in the tank. This mixing can lead to a decrease in the concentration of both pathogens and chemical contaminants in that pulse. **Retaining** the water in the tank provides time both to identify that an off-spec event has occurred and to enact a response to prevent that water from being distributed.

The amount of dilution that occurs depends both on the size of the reservoir and the duration of the off-spec event: a) the larger the reservoir, the greater the dilution, and b) the longer the off-spec pulse the lower the dilution. Figure 3-1 shows three different-sized ESBs—providing 4, 8, and 24 hours of hydraulic retention time (HRT)—and the degree of dilution during off-spec water events of increasing duration[5].

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[5] To simplify the illustration, it is assumed that all storage tanks behave as continuously stirred tank reactors (CSTR)

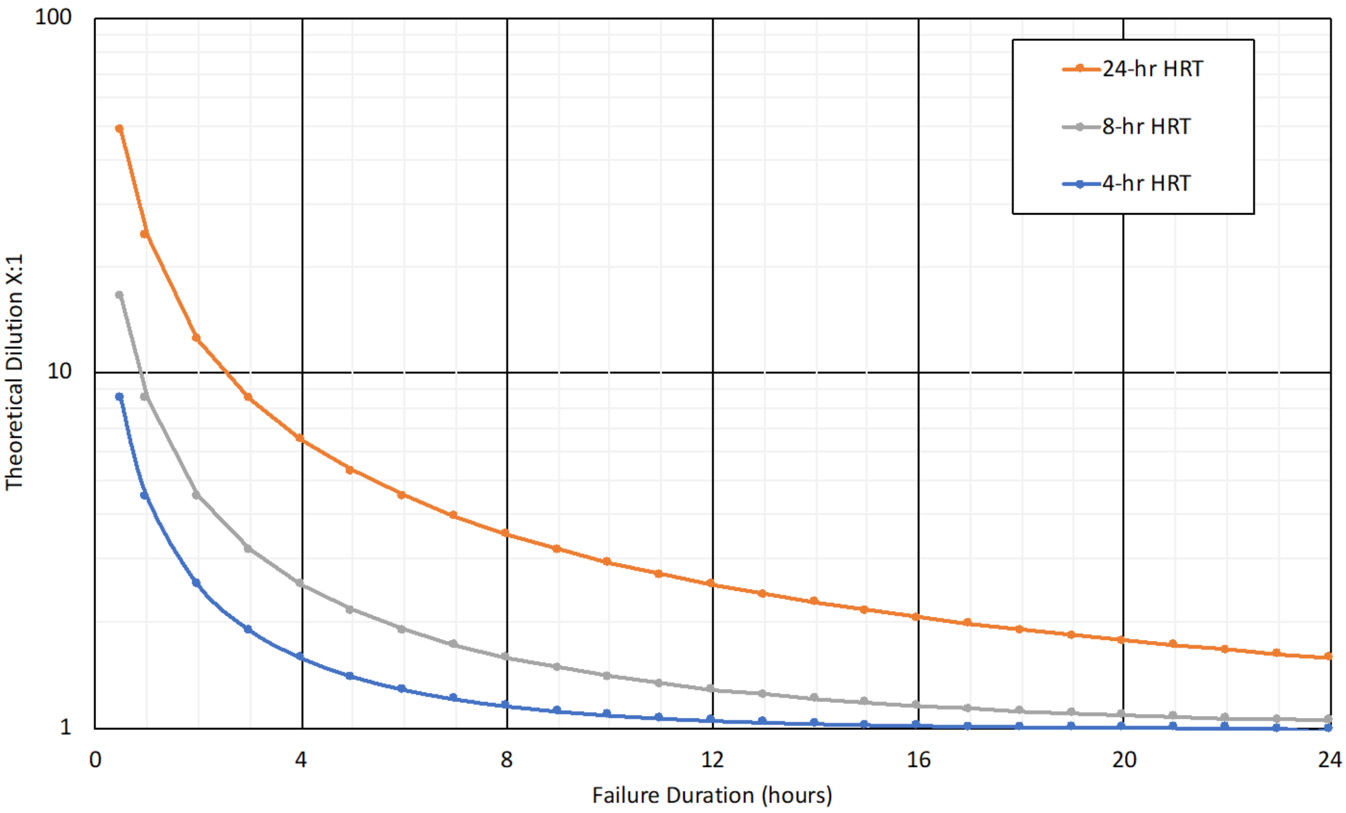


Figure 3-1. Dilution provided by a range of ESBs against off-spec water events. Results assume complete mixing in the storage tanks.

At what point should the dilution provided by a tank be considered significant or negligible? For pathogens, a 10-fold reduction (i.e., 1-log) could be used as the threshold for significance since control requirements are measured on a log scale. Figure 3-1 shows that 4- and 8-hour storage tanks would only meet this 10-fold threshold for failures lasting less than 15 minutes and 1 hour, respectively. A large, 24-hour storage tank would provide more protection but only for failures lasting up to 3 hours. ESBs are, therefore, unlikely to provide significant protection against pathogens unless the failures are of very short duration (< 1 hour).

Nevertheless, storage tanks can also provide retention time to respond to failure events. Unfortunately, designing a tank to maximize one of these benefits comes at the expense of the other. Tanks with ideal mixing characteristics (e.g., such as the CSTRs shown in Figure 3-1) maximize dilution, but allow some of the pulse to pass immediately through the tank. Tanks that maximize retention time (e.g., plug flow reactors or PFR), however, provide minimal dilution. Therefore, trade-offs will be needed in the design of storage tanks and other ESBs. Based on this evaluation, the DPR storage facilities presented in the Master Plan seek to maximize retention time rather than mixing and dilution.

3.2.3 Blending

Blending—or the commingling of different flows—is another element of a potable reuse project that can be used to improve water quality in potable reuse settings. Blending advanced treated effluents with other source waters (e.g., surface or groundwaters) reduces the concentration of contaminants at a level equivalent to the blend ratio. To achieve a 1-log reduction of pathogens, however, assumes that advanced treated effluents make up only 10 percent of the total flow. While it is unlikely that such low blending ratios will be applied in DPR settings, this contaminant control strategy could be quantified and included in evaluations of public health protection.

3.3 Chemical Control

Environmental buffers also provide protection against toxic chemicals. Multiple mechanisms of attenuation occur in aquifers and reservoirs—including adsorption, photolysis, and biodegradation—whose benefits are being increasingly understood and quantified (Trussell 2018). Contaminant peaks have also been shown to be dampened as off-spec water travels, disperses, and mixes with other sources in the environment (Olivieri et al. 2016, Pecson et al. 2018). Eliminating the environmental buffer means that DPR systems will lose these chemical control benefits. As a result, the State Board is addressing two chemical research topics through its priority DPR research efforts: 1) the control of chemical peaks that enter potable reuse trains, and 2) unknown, low-molecular-weight compounds that may pass through the FAT train. These two topics are likely to be included in the future regulations to address chemical control in DPR.

3.3.1 Treatment

Decades of experience have shown that the FAT train provides excellent protection against nearly all categories of chemical compounds, including those with MCLs, NLs, and a wide selection of CECs. The process can also bring the bulk organics to very low levels that are typically below 100 micrograms per liter (µg/L) of TOC.

The compounds that remain are generally recalcitrant to the numerous treatment mechanisms included in the FAT train—size exclusion, charge exclusion, UV photolysis, and advanced oxidation. These compounds tend to be low-molecular-weight, uncharged compounds that are capable of passing through RO (Breitner et al. 2019). Acetone is a commonly cited example due to its repeated detection in the effluent of Orange County Water District's Groundwater Replenishment System, though other recalcitrant compounds—including aldehydes and trihalomethanes—have also been identified (Olivieri et al. 2016, Tackaert et al. 2019). The State Board has indicated that they will require additional chemical protection for DPR to further attenuate and dampen such peaks.

The State Board has not indicated what additional treatment will be needed to satisfy the chemical control requirements, but is actively evaluating this topic in its DPR-4 Research Project (Debroux and Trussell 2019). Based on the lessons from 50+ years of groundwater recharge, one strategy for dealing with unknown contaminants is to increase the robustness of the treatment train (Pecson et al. 2015, Olivieri et al. 2016, SWRCB 2019b). The greater the diversity of removal mechanisms, the less likely it will be that a compound will not be addressed by at least one of the mechanisms. The following sections evaluate options that add robustness to the treatment train and address the new DPR chemical control goals.

O3/BAC. FAT pre-treatment with ozone and biological activated carbon (O3/BAC) increases treatment robustness by adding new mechanisms of control, including chemical oxidation, biodegradation, adsorption, and physical removal. By increasing robustness, O3/BAC pre-treatment provides additional protection against unknown contaminants.

It has also been shown to provide significant benefits in the control of chemical peaks. A recent study evaluated two treatment trains—the FAT train and an O3/BAC-FAT train—in their ability to control a set of low-molecular-weight, uncharged compounds (Tackaert et al. 2019). These four compounds—acetone, formaldehyde, N-nitrosodimethylamine (NDMA), and 1,4-dioxane—are known to be incompletely removed through the FAT train alone. In every case, O3/BAC provided protection beyond that provided by the FAT train (Figure 3-2). The O3/BAC-FAT train is being studied under the DPR-4 Research Project to evaluate its ability to provide control of chemical peaks in DPR settings (Debroux and Trussell 2019). By providing control against chemical peaks, \ unknown chemical contaminants, and pathogens, the O3/BAC-FAT treatment train has been identified as a candidate treatment train for DPR (Pecson et al. 2017, Olivieri et al. 2016).

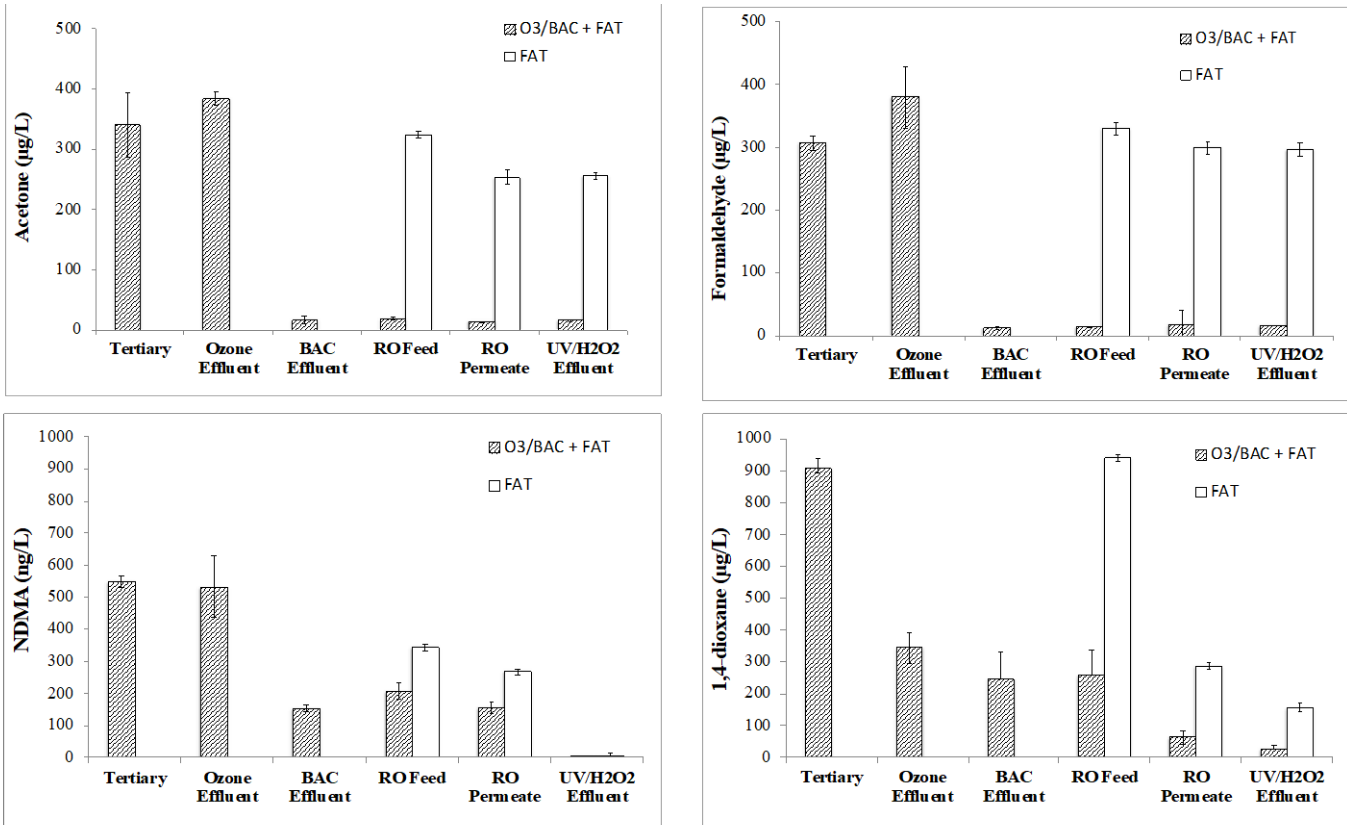


Figure 3-2. O_3/BAC pre-treatment provides additional protection against peaks of chemicals known to be incompletely removed by the FAT train (courtesy of Tackaert et al. 2019)

In addition to improving the quality of the treated effluent, O3/BAC pre-treatment can also improve the quality of the RO concentrate. It does this by breaking down, biodegrading, and removing organic compounds before the RO separates those compounds into the concentrate stream. One way to visualize the change in the organic make-up of the RO concentrate is through the use of excitation-emission matrices (EEM). With O3/BAC pre-treatment, both the RO feed and the concentrate have lower amounts of material that is observable in the EEM (Figure 3-3). This additional benefit of O3/BAC pre-treatment may allow for easier RO concentrate management and discharge, particularly with regard to the control of toxic organic compounds and CECs (Kenny, J. et al. 2018).

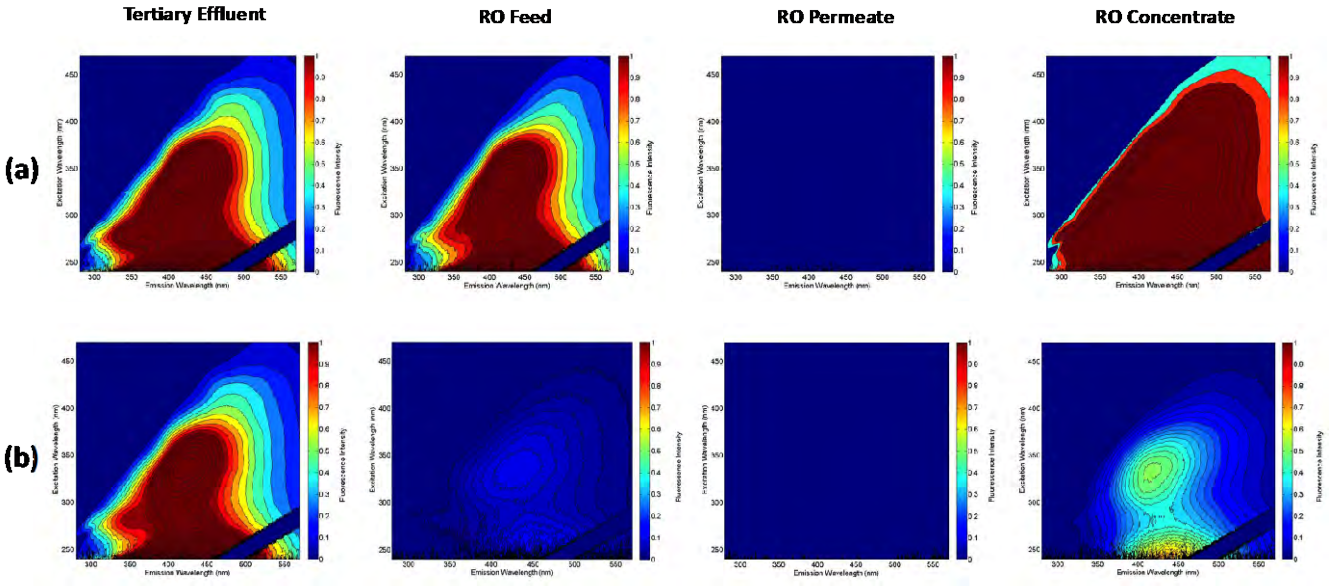


Figure 3-3. Excitation-emission matrices of AWPF membrane feed water, RO permeate, and RO concentrate (a) without O_3/BAC pre-treatment and (b) with O_3/BAC pre-treatment

Granular Activated Carbon. Another commonly cited option to enhance the robustness of the FAT treatment train is granular activated carbon (GAC). GAC is particularly effective at the adsorptive removal of uncharged, hydrophobic compounds, such as trichloroethylene (TCE) from contaminated sources. GAC provides limited protection, however, against many of the uncharged, polar compounds that are known to pass through the FAT train. Adsorption modeling was done to evaluate the ability of GAC to provide protection against two known toxic, low-molecular-weight compounds (NDMA and 1,4-dioxane) as well as two “sentinel” low-molecular-weight, polar compounds that have also been shown to pass through the FAT train (acetone and formaldehyde). The modeling assumed a standard design empty bed contact time (EBCT) of 15 minutes using Calgon F-400 GAC, and based the concentrations of the four polar, low-molecular-weight compounds on values used in Tackaert et al. (2019): NDMA at 550 ng/L, 1,4-dioxane at 10 µg/L, acetone at 2.7 mg/L, and formaldehyde at 307 µg/L. Removal of these compounds was compared against 150 µg/L of TCE, a groundwater contaminant often treated through GAC columns downstream of RO (Figure 3-4).

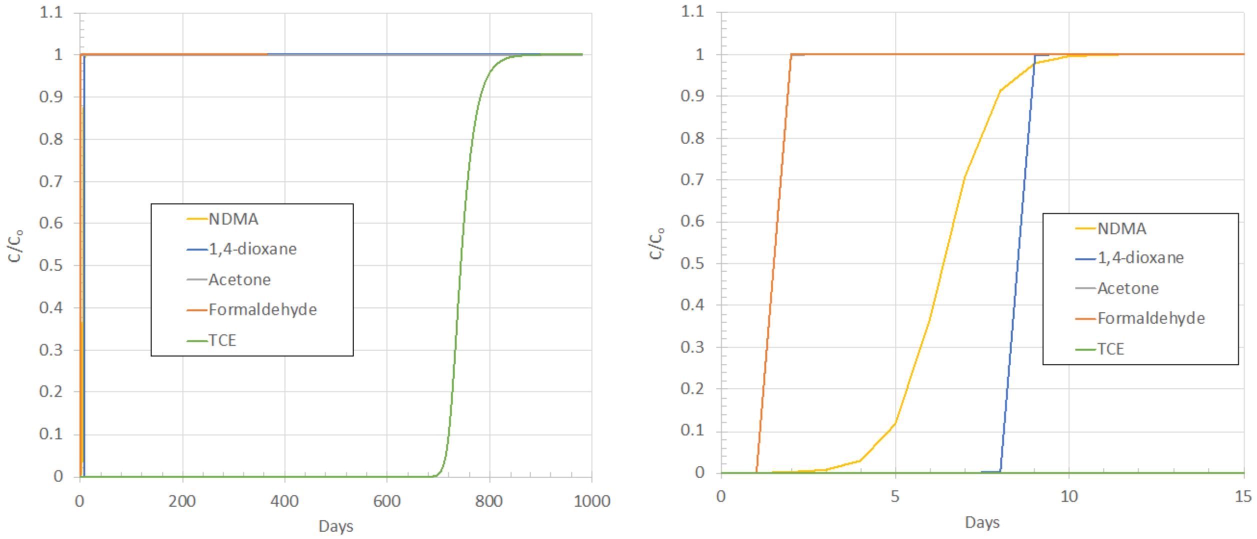


Figure 3-4. Modeling of GAC removal of TCE and four low molecular weight, polar compounds known to pass through the FAT train: NDMA, 1,4-dioxane, acetone, and formaldehyde.

Left figure shows the GAC breakthrough curves for all compounds with the right figure focusing on breakthrough in the first 15 days.

The figure shows that the GAC columns could control a well-removed compound (TCE) for a period of approximately 800 days before needing replacement. This is a typical replacement frequency for GAC, which has proven to be an economically feasible approach for many groundwater applications. The polar compounds, however, exhaust the GAC and require replacement in as little as 2 to 10 days—a consequence of their poor adsorption onto activated carbon. This frequent rate of GAC change-out is infeasible from an operational and maintenance point of view and would also have a prohibitive economic impact.

In addition to looking at the removal of compounds that are consistently present, modeling was also undertaken to evaluate GAC's ability to attenuate chemical peaks. Modeling of a 12-h pulse of acetone at 10 mg/L (similar in magnitude and duration to the event described at OCWD's GWRS) showed only a 43% reduction through GAC, i.e., less than a 2-fold reduction of the peak height (Figure 3-5). Assuming chemical peaks may need to be attenuated up to 10-fold to provide meaningful protection, this example illustrates that GAC may have limited ability to attenuate the peaks of relevant low molecular weight compounds.

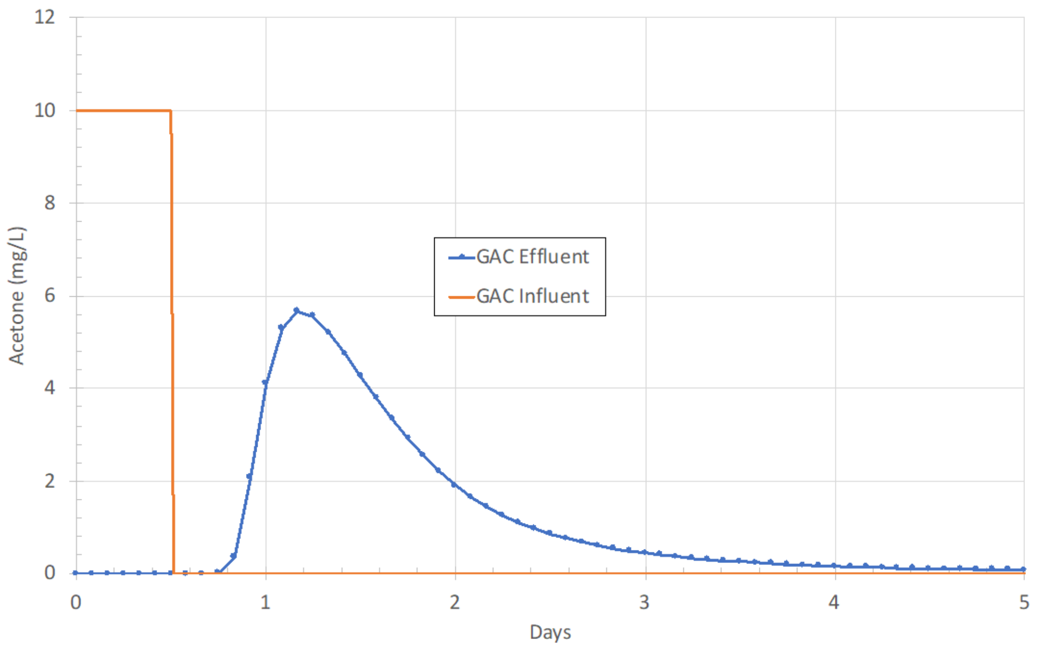


Figure 3-5. GAC provides limited reduction of a 10 mg/L pulse of acetone

(assuming 15-minute EBCT of Calgon F-400)

While GAC is effective at removing certain compounds, it will provide limited protection against the polar, low-molecular-weight compounds (both known and unknown) that are either consistently present in treated effluents or come through in peaks. Furthermore, GAC is strictly a chemical removal process that will not provide benefits in terms of pathogen credits.

Air stripping. Air stripping adds robustness to the FAT train by promoting the transfer of volatile organic compounds (VOC) from the aqueous to the gaseous phase. Their removal is a function of multiple factors, including the ratio of air to water, the hydraulic loading rate, temperature, and the volatility of the compound. Consequently, air stripping would have variable effectiveness against the types of compounds likely to persist through the FAT train, with greater effectiveness against more volatile compounds such as trihalomethanes (THM). Like GAC, air stripping would not provide additional control of pathogens and may allow for new contaminants to enter the treated water through exposure to the atmosphere. The growth of biological communities in the basins or towers may also require a downstream process (such as filtration or disinfection) to control the sloughing and release of microorganisms into the treated water.

3.3.2 Source Control

While treatment may be the primary means to control chemicals in DPR settings, management barriers including source control can also reduce the load and diversity of chemical compounds entering in the raw wastewater. The State Board has indicated that DPR source control programs will need to extend beyond both the National Pretreatment Program and the existing requirements from the IPR regulations (Figure 3-6). Reducing the input of chemicals into the system provides protection against chemical peaks, reduces the concentration of hard-to-treat or recalcitrant compounds, and offers another layer of protection against both known and unknown compounds.

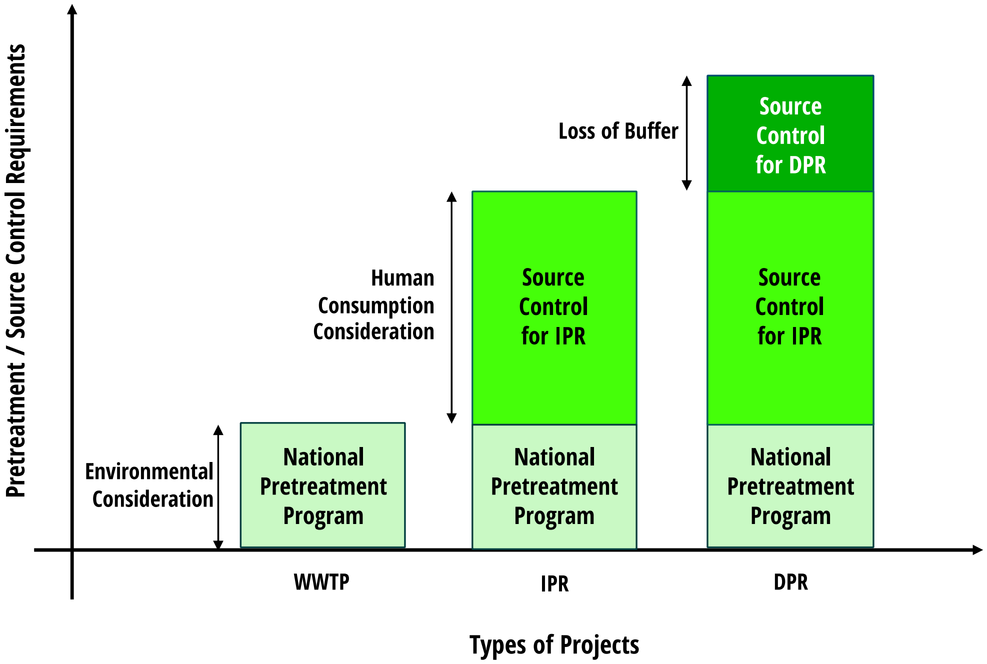

Pretreatment / Source Control Requirements
Loss of Buffer
Source Control for DPR
Human Consumption Consideration
Source Control for IPR
Source Control for IPR
Environmental Consideration
National Pretreatment Program
National Pretreatment Program
National Pretreatment Program
WWTP
IPR
DPR
Types of Projects

Figure 3-6. Source control for DPR may be stricter than IPR to account for the loss of the environmental buffer

3.3.3 Dilution and Blending

Section 3.2.2 described the benefits of dilution to control pathogens and highlighted the importance of storage tank size (i.e., HRT) in determining its benefits. Storage tanks with 4- to 8-hour HRTs can provide significant (i.e., 5- to 10-fold) reductions in contaminant concentrations, but only for short-duration failures of 1 to 2 hours. Whether this level of protection will be sufficient to satisfy the State Board's future requirements for chemical peak attenuation is not clear. Another RWA project being pursued in the State is the City of San Diego's Phase 2 Pure Water Project, which is evaluating the use of a reservoir that provides 30-day HRT. Given the large size of this reservoir compared to an engineered storage tank, significant degrees of dilution and chemical peak attenuation will be achieved. The City of San Diego is currently engaging the State Board to evaluate whether additional treatment beyond the reservoir is necessary to satisfy the chemical peak requirements. In addition to the reduction in contaminant concentrations, the passage of water through a storage tank or reservoir also provides time to respond to treatment issues and divert or further treat the water before distribution to consumers. Like dilution, blending can also be used to control both chemical peaks and unknown contaminants, but its benefits will be a function of the ratio of treated effluents to other water sources.

3.4 Failures and Response

Retention time is a key benefit in IPR projects because it provides an opportunity to address failures and other water quality excursions before they impact consumers. As long as the time to respond to issues is shorter than the retention time in the system, this approach is feasible. In DPR settings, however, there may be only hours of time between treatment and distribution—meaning DPR retention times will be orders of magnitude shorter than IPR (i.e., hours vs. months). DPR systems will need to compensate with new approaches to address this challenge since even rare, short-term failures significantly impact public health (Amoueyan 2017, Pecson 2017).

3.4.1 Failure Prevention

Many drinking water treatment plants prevent water from failing to meet requirements by providing a level of treatment beyond the minimum that is required. Common operational and design strategies used at drinking water treatment plants (including Valley Water's facilities) include:

- Use of concurrent disinfection processes: drinking water treatment plants may simultaneously use multiple forms of disinfection (e.g., chlorine and ozone) either of which alone would be sufficient to meet the minimum requirements. The failure of one system (including a complete unit process failure) would not cause the water to be off-spec since the redundant system is also in use.
- Use of disinfection "CT Ratio": drinking water treatment plants often operate with a disinfection CT (i.e., the product of the disinfectant residual "C" and the contact time "T") that is multiple times the minimum CT required. For example, if a permit required a CT of 5 mg-min/L, the operators may actually target a CT of 10 to 15 mg-min/L in order to have a CT ratio that is 2 to 3 times higher than the minimum.

The rationale for these two operational scenarios stems from the fact that potable water systems must continuously assure the quality of the water. By providing redundancy, the system can withstand excursions in treatment, monitoring, and operations without compromising the system's ability to produce acceptable water. A recent study demonstrated that an O_3/BAC-FAT treatment train provided sufficient redundancy in pathogen control to ensure a high degree of protection even in the face of process failures (Pecson 2017). The State Expert Panel also evaluated this treatment train and concurred that this level of protection should be sufficient for DPR (Olivieri et al 2016).

In addition to redundancy, treatment systems also benefit from multiple, different barriers (i.e., robustness) that provide more complete protection against the diversity of contaminants. Examples include the requirement for both filtration and disinfection under EPA's Surface Water Treatment Rules or the requirement for both UV photolysis and AOP for enhanced chemical control in the IPR regulations. Non-treatment barriers may also help prevent failures by reducing the load of contaminants entering a DPR system (i.e., source control), confirming that barriers are effective (i.e., monitoring), and improving water quality through dilution (i.e., storage tanks and reservoirs) and blending with other source waters.

3.4.2 Failure Response

Failure response relates to the identification of failures (either confirmed or presumed) and the triggering of actions to prevent the off-spec water from being distributed to consumers. Multiple elements are involved in failure response, including monitoring, control systems, diversions, and storage buffers that provide time to enact corrective actions. While failure prevention and failure response can be balanced in different proportions, this decision will impact the system's operational flexibility.

Systems with lower degrees of failure prevention (e.g., less treatment redundancy) may be required to compensate with higher degrees of automated system controls that divert off-spec water or shut down the system when performance is compromised. By having a narrower acceptable operational range, such systems may be impacted with lower levels of availability, a correspondingly higher unit cost of water, and more frequent interactions with regulators to reduce the probability of future off-spec events. Frequent failures may not only challenge the owner and regulators but also potentially damage public confidence in the water system.

A system with higher degrees of redundancy may not require the same level of automated responses, particularly if the system can demonstrate its resistance to failures (Pecson et al. 2017). Non-treatment barriers may also be effective at providing flexibility to deal with off-spec events. For example, a system with significant storage—such as a reservoir that provides multiple days or weeks of storage—may be able to operate with less strict automated responses since the reservoir provides time for operators to evaluate and respond to issues. This retention time allows for greater operational flexibility by delaying the entrance of water into the distribution system.

3.5 Technical, Managerial, and Financial Capacity

The 1996 federal Safe Drinking Water Act requires states to incorporate TMF capacity into public water system operations. In response to this requirement, California enacted Section 116540 of the Health and Safety Code, which states:

> *"No public water system that was not in existence on January 1, 1998, shall be granted a permit unless the system demonstrates to the DDW that the water supplier possesses adequate financial, managerial and technical capability to assure the delivery of pure, wholesome, and potable drinking water. This section shall also apply to any change of ownership of a public water system that occurs after January 1, 1998."*

DDW has expressed that the TMF requirements for DPR will be more restrictive than the TMF requirements for IPR. In its Proposed Framework for Regulating Potable Reuse, DDW states the following regarding TMF:

> *"The technical, managerial, and financial (TMF) capacity required to build, maintain, monitor, and operate a potable reuse project increases with the complexity and sophistication of the system required. The complexity and sophistication is a function of the number and types of treatment processes, monitoring methods, and control points. These increase as the type of potable reuse goes from IPR to DPR." (SWRCB 2019b)*

For potable reuse projects, it is imperative that public water systems have sufficient TMF capacity to reliably operate and maintain the project. This is particularly important in DPR settings due to the loss of the environmental buffer and greatly reduced response times. Public systems pursuing DPR will need to have sound TMF capacity from source control all the way to the consumer to ensure public health protection at all times.

3.6 Aesthetics

Beyond addressing public health requirements, FAT trains also produce aesthetic, high-quality effluents that are low in color, turbidity, and odor. They are typically also treated to match the mineral content of existing source waters to create a water that is compatible with the drinking water distribution system and does not provoke colored water events. The temperature of purified water is frequently multiple degrees Celsius warmer than conventional drinking water sources. In IPR, this difference is mitigated by the fact that purified water spends significant time in the environment and frequently blends with other waters to match ambient temperatures. One new challenge for DPR will be to ensure that the temperature of the water is acceptable from an aesthetics standpoint (SWRCB 2019b, Tchobanoglous et al. 2015).

3.7 Summary of Public Health Considerations for RWA and TWA

Based on the known and anticipated considerations for DPR (both RWA and TWA) described above, the rubric shown in Table 3-2 has been developed to evaluate and score the portfolios. The scoring has been adjusted to account for the fact that there is neither regulatory certainty nor precedents for DPR in California. Like the other rubrics, each category is divided in terms of color—light blue, medium blue, and dark blue—to indicate the anticipated relative ease or difficulty of permitting with regard to each topic. More detailed, portfolio-specific discussion provided in Section 6.1.

Table 3-2. Rubric for evaluating public health criteria in RWA and TWA portfolios

	Pathogens	Chemicals	Source Control
	≥15/13/13	High-quality WW to FAT train with enhanced robustness and multiple additional barriers	
	< 15/13/13	High-quality WW to FAT train with enhanced robustness and moderate additional barriers	Source control program likely to meet the enhanced requirements specified in future DPR regulations
		DPR train with less robustness or more challenging source water or fewer barriers	Includes challenging source waters that require source control measurements beyond minimum future requirements
	Monitoring and Control	**Retention and Response Time**	**TMF Capacity**
		≥ 24 hours retention prior to distribution (e.g., reservoir, clearwell)	
	Enhanced control system with *multiple* additional barriers (treatment, blending, retention)	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell)	Agencies with more AWPF experience and existing interagency agreements
	Enhanced control system with *moderate* number of additional barriers	< 8 hours retention prior to distribution (e.g., reservoir, clearwell)	Agencies with less AWPF experience or lacking formalized interagency agreements

Pathogens. Based on the discussion above, a "light blue" ranking was assigned to projects providing redundancy beyond the anticipated minimum requirements for DPR (15/13/13). A 2-log redundancy was used to distinguish the "light blue" category. "Medium blue" was assigned for projects providing minimal to no redundancy above the 15/13/13 benchmark, and "dark blue" for projects providing less than the benchmark.

Chemicals. Portfolios were assigned "light blue" rankings for systems that include enhanced robustness in the treatment train along with multiple additional barriers, such as enhanced source control, high-quality wastewater treatment with nutrient removal and filtration, dilution, and mixing in a reservoir or ESB. Portfolios providing multiple , barriers were assumed to provide a high degree of protection against both unknown chemicals and chemical peaks. "Medium blue" and "dark blue" rankings were assigned to similar systems, but with increasingly lower numbers of control barriers or less treatment robustness.

Source control. As discussed in Section 3.3.2, the State Board has indicated that DPR source control programs will need to extend beyond the existing requirements for IPR. The findings and recommendations from the State's DPR source control panel have not been released, but preliminary strategies include enhanced monitoring of collection systems for volatile organic compounds, segregation of challenging waste streams, more frequent analysis of chemicals to include for control using local limits, and diversion at the AWPF to reroute purified water during periods when chemical peaks are detected at the facility. Given the uncertainty in the future requirements for the enhancements needed for DPR source control programs and the lack of additional direction from DDW during the June 9, 2020 meeting, the "light blue" scoring was not developed for DPR. The "medium blue" scoring was assigned for most projects under the assumption that they would be able to make the necessary enhancements to meet the stringent, future source control requirements. "Dark blue" was assigned if the project uses a challenging source water that might trigger source control measurements beyond the minimum future requirements.

Monitoring and control. One key difference in the DPR scenarios is the step-change reduction in response time: from the months provided in IPR scenarios to the hours available in the three DPR scenarios. One technical topic of interest is, therefore, demonstrating the capacity to rapidly integrate performance data and respond to failures in the short available retention times. DPR systems will also have to include rapid responses to any failures (presumed and confirmed) based on on-going performance evaluation, with the stringency of this requirement tied to the amount of retention time in the system. This topic represents one of the biggest technical challenges to DPR implementation. The lack of a “light blue” ranking for this category reflects this fact. The reliance on the control system is also dependent on the degree of additional barriers present. “Medium blue” was assigned to portfolios providing multiple additional barriers (e.g., treatment, blending, retention time) in addition to the monitoring and control system. “Dark blue” was assigned to portfolios with a moderate to low degree of additional barriers.

Retention and response time. While SWA systems must provide minimum theoretical retention times of more than 60 days in the reservoir, they are also required to show that the reservoir provides at least 100:1 or 10:1 dilution of any 24-hour pulse of off-spec water. In essence, the SWA regulations imply that all failures and excursions that may impact water quality will be detected and addressed with a 24-hour window. Building off of this precedent, DPR systems also providing 24 hours or more of retention time were assigned a “light blue” ranking. “Medium blue” was assigned to projects providing no less than 8 hours of retention time, and “dark blue” for < 8 hours. The amount of retention time required will be highly dependent on the effectiveness of DPR monitoring and control systems, with the “medium blue” and “dark blue” criteria requiring adjustment once it is better understood how much time is needed to detect and respond to failures in DPR scenarios.

TMF capacity. Because DPR requires the highest degree of complexity and sophistication, the State Board has indicated that it will have the strictest TMF requirements for RWA and TWA. DDW has highlighted the importance of this topic by stating that TMF capacity may be used to pre-qualify agencies seeking to pursue DPR projects. DDW has signaled that interagency coordination will be of greater importance for DPR to ensure the effectiveness of elements that span across agencies. Examples of heightened coordination include the need for enhancements to source control programs and potential future requirements for the optimization of wastewater treatment plants feeding DPR AWPFs. Agreements specifying these roles and responsibilities may be of greater importance than in IPR settings. Given the uncertainty in TMF requirements, “medium blue” is assigned the highest ranking and corresponds to the involvement of agencies with greater AWPF experience (technical capacity), lower numbers of agencies (less management complexity), and existing interagency agreements (greater management certainty). “Dark blue” is assigned to projects involving multiple agencies, those with less experience and/or resources, or projects that have not formalized binding agreements between agencies.

Having developed the rubrics to evaluate GWR, SWA, and DPR in the previous two sections, the following three sections evaluate each of the potable reuse portfolios in terms of their relative ease or difficulty in achieving regulatory compliance.

Section 4: Groundwater Recharge Portfolios

The GWR portfolios evaluated in the Countywide Master Plan cover a range of options that use multiple supply sources, multiple potential AWPFs, and varying design capacities and yields (Table 4-1). Nevertheless, they have many similarities with regard to advanced treatment facilities and delivery points. All of the GWR portfolios evaluated in this regulatory TM use a FAT-based treatment train (Figure 4-1) to produce a purified effluent for surface spreading at the LGRP. In the following sections, the four portfolios are evaluated based on their ability to comply with the regulatory requirements for public health (described in Section 2.1) and environmental compliance (described in Section 2.2).

Table 4-1. Key Attributes of the Four Groundwater Recharge Portfolios

GWR Portfolio	Design Capacity (mgd)	Annual Production (AFY)	AWPF Location	Source Supply
Portfolio 1a	24 mgd	24,000	Adjacent to Silicon Valley Advanced Water Purification Center (SVAWPC)	SJ/SC RWF
Portfolio 2a	24.5 mgd	17,300-23,000	Regional facility at former Los Altos Treatment Plant	PA RWQCP and Sunnyvale WPCP
Portfolio 2a	24.5 mgd	17,300-23,000	Regional facility at Sunnyvale	PA RWQCP and Sunnyvale WPCP
Portfolio 4	14 mgd at Palo Alto; 10.5 mgd at Sunnyvale	17,300-23,000	AWPFs at former Los Altos Treatment Plant and Sunnyvale	PA RWQCP and Sunnyvale WPCP

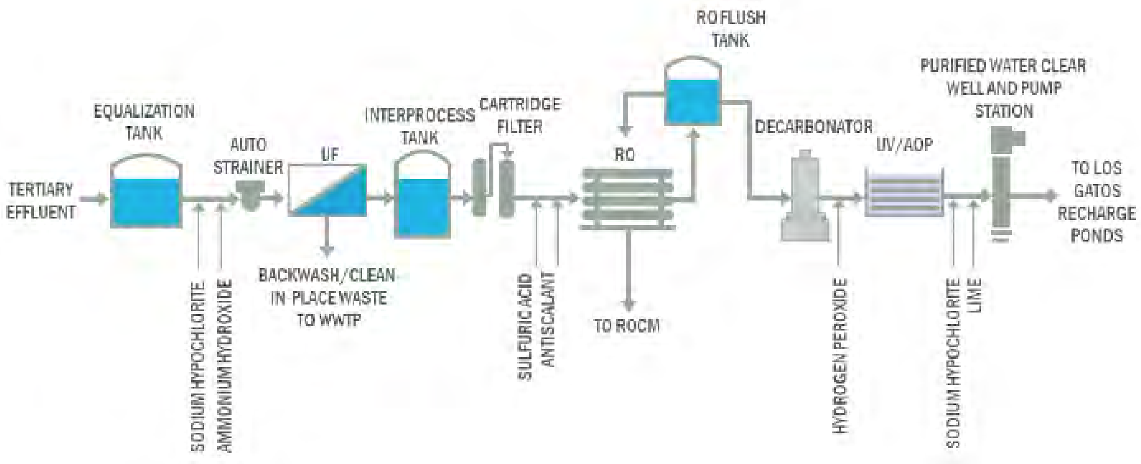


Figure 4-1. Proposed AWPF treatment train for the groundwater recharge portfolios

4.1 Public Health Criteria

4.1.1 Pathogens

The treatment train for the GWR portfolios (1a, 2a, 2b, and 4) provides a high degree of pathogen log reduction that exceeds the minimum 12/10/10 log reduction values for GWR (Section 2.1.1). The anticipated pathogen reduction credits are presented in Table 4-2. One benefit of surface spreading projects is that they can receive credit for the full 10-log reduction requirement for both *Giardia* and *Cryptosporidium* if the purified water is retained for 6 or more months in the aquifer. Consequently, the GWR portfolios provide significant pathogen redundancy, since both the FAT treatment and the aquifer alone meet or exceed the *Giardia* and *Cryptosporidium* requirements. Multiple GWR projects that use the FAT train do not recharge via surface spreading, but via subsurface injection. From a pathogen control perspective, the GWR portfolios in the Master Plan would also have a straightforward permitting approach for subsurface injection, providing a high degree of permitting flexibility to move from spreading to injection in the future. Given the high degree of treatment provided both at the AWPF and the environment, all the GWR portfolios meet the "light blue" category for pathogen control (Table 4-3).

Table 4-2. Pathogen Reduction Credits Expected for GWR Portfolios 1a, 2a, 2b, and 4

Unit Process	Virus	*Giardia*	*Cryptosporidium*
Tertiary Treatment	0.4	0.2	0
MF	0	4	4
RO[a]	1.5	1.5	1.5
UV-AOP	6	6	6
Underground Retention[b]	6	10[c]	10[c]
Total	13.9	21.7	21.5
Required	12	10	10

a. *Assumes use of standard RO surrogates for pathogen crediting (e.g., conductivity, TOC).*

b. *Groundwater modeling results show purified water introduced at LGRP is retained for at least one year before reaching potable supply wells (D7 Table 2-6). Table assumes 6 months of retention time is credited for the LGRP portfolios.*

c. *10-log reduction credits for Giardia and Cryptosporidium apply for surface spreading projects that provide 6 or more months of retention time in the aquifer*

Table 4-3. Regulatory Considerations for Pathogen Control in the Groundwater Recharge Portfolios

1A	2A/2B	4
12/10/10 with ≥ 6 months of retention time	12/10/10 with ≥ 6 months of retention time	12/10/10 with ≥ 6 months of retention time

4.1.2 Chemicals

The GWR regulations contain chemical control requirements for all of the regulated drinking water constituents, along with a suite of unregulated compounds (Section 2.1). Based on the documented performance of FAT treatment trains to control chemical contaminants in GWR settings, along with site-specific performance data from the SVAWPC (Valley Water 2016), it is anticipated that the future GWR portfolios will be able to comply with the chemical control requirements for GWR (Table 4-4).

Table 4-4. Regulatory Considerations for Chemical Control in the Groundwater Recharge Portfolios

1A	2A/2B	4
FAT with no challenging source water	FAT with no challenging source water	FAT with no challenging source water

Periodically, the State Board updates the monitoring requirements in consultation with their Science Advisory Panel for CECs. Most recently, the Recycled Water Policy was updated to include requirements for the use of bioassays to provide non-targeted monitoring against groups of chemical compounds (SWRCB 2019c). Based on preliminary data, the FAT train should achieve a water quality that complies with the additional monitoring requirements. Data from the State's current bioassay monitoring phase should be available in the next one or two years. RO treatment is also effective at controlling the recently regulated perfluorinated compounds (PFOA and PFOS) down to acceptably low concentrations.

4.1.3 Source Control

A source control program will be required for all of the potable reuse portfolios and must comply with the requirements outlined in Section 2.1.1. Unlike the previous two criteria (pathogen and chemical control), important differences may exist between the GWR portfolios that warrant site-specific evaluations. The following sections describe the three approaches associated with Portfolios 1a, 2a/2b, and 4.

4.1.3.1 Portfolio 1a

The City of San José, on behalf of the SJ/SC RWF, a joint powers authority, currently administers an industrial pretreatment and pollutant source control program that complies with the requirements of the National Pretreatment Program mandated under the Clean Water Act. The existing source control program will need to be expanded to further protect recycled water sources intended for GWR. This new effort would target contaminants of public health concern for potable applications, including chemicals with MCLs, public health goals (PHGs), NLs, and other Department- and Board-specified chemicals. Through this effort, the City would be required to enhance the source control program to:

- investigate the fate of these chemicals through the wastewater and recycled water facility
- investigate and monitor the source of the chemicals
- mitigate discharge of the chemicals through enforcement of commercial/industrial discharge and through public outreach for residential discharge
- maintain an inventory of chemicals discharged into the collections system

It is assumed that the City of San José would continue to administer the source control program for Portfolio 1a. Implementing an expanded source control program for Portfolio 1a is facilitated by the fact that an existing program is in place and is completely within the jurisdiction of a single project partner. Furthermore, source control programs have been established for many GWR projects providing greater regulatory clarity. Based on this evaluation, Portfolio 1a falls into the “light blue” category (low difficulty) for source control. During discussions with DDW on June 9, 2020, it was confirmed that DDW will not require that a formal interagency agreement be in place that defines the roles and responsibilities related to source control. While such an agreement falls outside of DDW’s regulatory requirements, such agreements will be beneficial to manage the project and ensure that the partners comply with their respective responsibilities.

4.1.3.2 Portfolios 2a and 2b

While the requirements for source control are equivalent to Portfolio 1a, Portfolios 2a and 2b present new challenges due to the fact that wastewater from two agencies will be supplying a single feed to the regional AWPF. This unique scenario will require the coordination of two existing source control programs, a situation that has not yet arisen in California’s GWR projects. The regulations state that recycled water used for GWR projects “shall be from a wastewater agency” that administers an industrial pretreatment and pollutant source control program. This uncertainty was discussed with the regulators during the June 9, 2020 meeting. Based on preliminary feedback from DDW and the Regional Board, they did not see any immediate hurdles to the presence of two separate source control programs continuing to operate in parallel. While the regulations describe a single agency overseeing the source control program, they would likely not require that the two programs be united under a single agency’s umbrella. By maintaining the two existing programs independently, a new interagency agreement would not be required to unite the programs. Based on this feedback, Portfolios 2a and 2b present no additional challenges compared to Portfolio 1, leading them to fall into the “light blue” category (low difficulty) for source control.

4.1.3.3 Portfolio 4

Portfolio 4 also includes two wastewater agencies though each agency would feed its own AWPF. One unique aspect of this portfolio is that the purified effluents from the two facilities would be blended and delivered to the LGRP for percolation. Based on preliminary feedback from DDW and the Regional Board, this portfolio—like Portfolios 2a and 2b—would not trigger additional regulatory hurdles since the existing source control programs could continue to operate in parallel. Consequently, Portfolio 4 is also assigned the “light blue” category for source control.

4.1.3.4 Source Control Summary and Next Steps

A summary of the regulatory challenges associated source control for the four GWR portfolios is presented in **Table 4-5.**.

Table 4-5. Regulatory considerations for Source Control in the Groundwater Recharge Portfolios

1A	2A/2B	4
Source control program meets the enhanced requirements specified in IPR regulations	Source control program meets the enhanced requirements specified in IPR regulations	Source control program meets the enhanced requirements specified in IPR regulations

4.1.4 Monitoring and Control

As described above, the stringency of monitoring and control will be a function of the degree of response time provided by the system. In all of the GWR scenarios, significant aquifer retention times (> 6 months) are available, meaning that these projects should be able to use the precedents established at existing GWR projects. Portfolios 1a, 2a, and 2b are evaluated separately to account for the fact that Portfolio 4 includes two AWPFs that may require additional coordination in monitoring and control.

4.1.4.1 Portfolios 1a and 2a/2b

The industry has extensive experience with the monitoring and control of GWR systems, including frameworks for demonstrating the effectiveness of critical control points for pathogenic microorganisms and chemical contaminants. Well-developed surrogate frameworks provide high-frequency confirmation of the performance of pathogen control barriers, with control systems designed to respond to deviations in performance and water quality. Since the 2009 update to the GWR regulations, GWR projects have been required to submit monthly reports on performance. This delay in the integration and reporting of performance data has been acceptable in GWR due to the long period of retention time provided by the environmental buffer. This delay may not be acceptable, however, for more direct forms of potable reuse, as will be discussed later.

Given the extensive industry experience with the monitoring and control of GWR systems, particularly those with extensive (> 6 month) retention times, Portfolios 1a, 2a, and 2b fall into the “light blue” category (low difficulty) for monitoring and control.

4.1.4.2 Portfolio 4

Portfolio 4 represents a unique scenario in California GWR projects with two separate AWPFs combining effluents for GWR. The monitoring and control requirements at the two facilities could be higher if DDW requires operational coordination between the two AWPFs. However, based on interaction with DDW during the June 9, 2020 meeting, they stated that they would not likely impose new requirements for inter-facility communication. Each AWPF could operate independently, with monitoring requirements largely restricted to each individual facility. Based on this feedback, Portfolio 4 also falls into the "light blue" category.

4.1.4.3 Monitoring and Control Summary and Next Steps

An overview of the monitoring and control requirements for the GWR portfolios is provided in Table 4-6.

Table 4-6. Regulatory Considerations for Monitoring and control in the Groundwater Recharge Portfolios

1A	2A/2B	4
Proven with many precedents Less stringent with longer retention times	Proven with many precedents Less stringent with longer retention times	Proven with many precedents Less stringent with longer retention times

4.1.5 Retention and Response Time

The numeric modeling results for recharge at the LGRP shows that underground retention time is at least 2 years (Todd Groundwater 2017). Correcting that value in line with the GWR regulations requires multiplying the modeled retention time by a factor of 0.5, meaning that the system would actually be credited for 12 months of retention time. While the regulations require no less than two months of aquifer retention time, most of the existing projects provide 6 months to years of retention time. Generally, DDW will use greater scrutiny of GWR projects whenever retention times drop below the 6-month threshold (Chang 2013, Pecson 2015). Because the anticipated retention time exceeds the 6-month threshold for all portfolios, they fall into the "light blue" category (low difficulty) for retention and response time (Table 4-7).

Table 4-7. Regulatory Considerations for Retention and Response Time in the Groundwater Recharge Portfolios

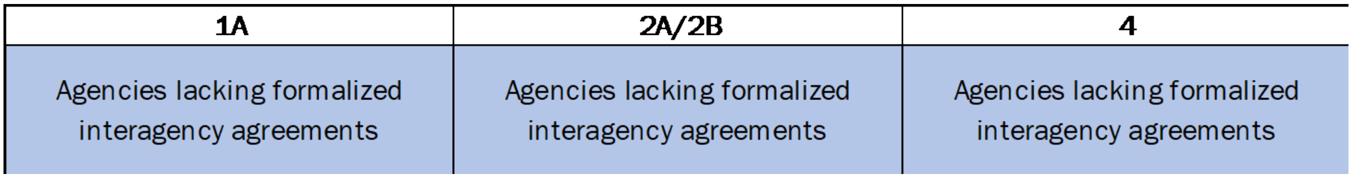
1A	2A/2B	4
≥ 6 months in the aquifer	≥ 6 months in the aquifer	≥ 6 months in the aquifer

4.1.6 TMF Capacity

As described in Section 3.5, DDW will require that agencies pursuing GWR possess the technical and managerial capacity to build, maintain, monitor, and operate potable reuse projects. The technical and managerial requirements increase with the complexity and sophistication of the system, which may be assessed based on the number and types of processes, monitoring methods, and the number of control points. Furthermore, DDW has stated that they will look at the existence of agreements between partner agencies that establish their roles and responsibilities during their evaluation of TMF. Such agreements demonstrate managerial capacity and the ability to ensure system reliability from source control and wastewater treatment through treatment at the AWPF and distribution.

Valley Water—who will oversee the operations and maintenance of the AWPFs—is a large agency with significant experience in advanced treatment. DDW has stated that additional efforts to demonstrate technical capacity—such as the use of a GWR demonstration project—would not be required assuming that the portfolios fall within the standard conditions of the regulation. Interagency agreements that define the roles and responsibilities of the partners, however, have not yet been completed. Consequently, the portfolios have been assigned a preliminary ranking in the "medium blue" category to account for this uncertainty (Table 4-8).

Table 4 8. Regulatory Considerations for TMF in the Groundwater Recharge Portfolios



1A	2A/2B	4
Agencies lacking formalized interagency agreements	Agencies lacking formalized interagency agreements	Agencies lacking formalized interagency agreements

Recommended next steps for TMF include:

- **Continuing to engage partners on interagency agreements**: Based on feedback from DDW during the June 9, 2020 meeting, agreements that provide definition on the roles and responsibilities of the various agencies would be beneficial during DDW's assessment of TMF. The existence of such agreements may provide further evidence of the project's ability to ensure the reliability of the potable reuse system. Topics of interest for such agreements could include defining the requirements for enhanced source control programs, the quality of the secondary or tertiary effluent that is acceptable as a feed water to the AWPF, and who is responsible for system upgrades and maintenance.

4.2 Environmental Compliance Criteria

Two discharge types for the GWR portfolios (1a, 2a, 2b, and 4) must be compliant with all applicable environmental regulations: ROC discharge and AWPF product water releases. The following sections describe the regulations and key considerations related to implementing the different GWR portfolios.

4.2.1 Reverse Osmosis Concentrate Management

The primary approach for ROC management for all portfolios involves the discharge of ROC into South SF Bay. The exception to this is the SWA portfolio, where the AWPF is located at Morgan Hill.

This section will be updated when the ROC management approaches have been finalized.

4.2.2 Product Water Release

All of the GWR portfolios involve the release of AWPF product water into LGRP with percolation into the Santa Clara Groundwater Subbasin. LGRP and the subbasin have designated beneficial uses in the SF Bay Basin Plan, meaning that a number of environmental regulations will apply to protect the existing quality of these waters. Additionally, water that percolates into the Santa Clara Subbasin must also meet the requirements specified in the SNMP. The following subsections describe the key aspects of the applicable environmental regulations that may impact AWPF product water release compliance.

4.2.2.1 SF Bay Basin Plan

The LGRP and the Santa Clara Subbasin have a number of beneficial uses defined in the SF Bay Basin Plan (Table 4-9).

Table 4-9. SF Bay Basin Plan Beneficial Uses for Los Gatos Recharge Ponds and Santa Clara Subbasin

Los Gatos Recharge Ponds (Campbell Percolation Ponds)	Santa Clara Subbasin
GWR	MUN
Commercial and sport fishing (COMM)	Industrial process water supply (PROC)
Cold freshwater habitat (COLD)	Industrial service water supply (IND)
Fish spawning (SPWN)	Agricultural water supply (AGR)
Warm freshwater habitat (WARM)	
Wildlife habitat (WILD)	
Water contact recreation (REC-1)	
Non-contact recreation (REC-2)	

The beneficial uses for both waters span human consumptive (MUN, GWR and COMM), industrial (PROC, IND), agricultural (AGR), aquatic life (COLD, SPWN, WARM), wildlife, and recreation uses. The SF Bay Basin Plan defines numeric and narrative water quality objectives to ensure that the defined beneficial uses are protected. The applicable water quality objectives per the SF Bay Basin Plan are different for surface waters and groundwater, and the following sections summarize these objectives and describe considerations that may impact the AWPF product water release.

4.2.2.1.1 Water Quality Objectives for Los Gatos Recharge Ponds

The beneficial uses for LGRP include protections for aquatic life and recreation but do not specify municipal uses for the water. Communication with the Regional Board to confirm these defined beneficial uses and associated water quality objectives will be an important part of future permitting efforts. For this initial assessment, this section describes the applicable water quality objectives to protect aquatic life habitat and recreation per the current-defined beneficial uses.

Narrative water quality objectives are included in the SF Bay Basin plan for bioaccumulation, biostimulatory substances, color, floating material, oil and grease, population and community ecology, radioactivity, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, and toxicity. In general, the narrative water quality objectives specify that constituents not be present at levels that cause nuisance or adversely affect beneficial uses. Table 4-10 provides a summary of the numeric water quality objectives that are applicable to Los Gatos Recharge Ponds.

Table 4-10. Summary of Numeric Water Quality Objectives for the Los Gatos Recharge Ponds

Parameter	Unit	Most Stringent Applicable Limit[a]	Associated Beneficial Use
Fecal Coliform	MPN/100 mL	Geometric mean < 200 90th Percentile < 400	Water Contact Recreation (REC-1)
Total Coliform	MPN/100 mL	Median < 240 No Sample > 10,000	Water Contact Recreation (REC-1)
Enterococcus	MPN/100 mL	Geometric mean < 35 No Sample > 104	Water Contact Recreation (REC-1)
Dissolved Oxygen	mg/L	≥ 7.0[b]	Cold water habitat (COLD)
pH	--	6.0 – 8.5[c]	Applicable to all surface waters in the SF Bay Basin Plan
Temperature	˚F (˚C)	Change from natural receiving water temperature ≤ 5 (2.8)	Applicable to all surface waters in the SF Bay Basin Plan
Turbidity	NTU	< 10% change for waters with natural turbidity > 50 NTU	Applicable to all surface waters in the SF Bay Basin Plan
Un-ionized Ammonia	mg/L	Receiving Water Concentrations: Annual Median = < 0.025 mg/L Maximum = 0.4 mg/L	Median applicable to all surface waters in the SF Bay Basin Plan, maximum applicable to water bodies in the Lower Bay
Chemical Constituents	--	See Table 3.4 in the SF Bay Basin Plan	Applicable to all surface waters in the SF Bay Basin Plan.

a. *Various beneficial uses may require different water quality objectives. This table shows the most stringent requirement that must be met per the SF Bay Basin Plan.*

b. *The median dissolved oxygen concentration for any three consecutive months shall not be less than 80% of the dissolved oxygen content at saturation.*

c. *pH changes greater than 0.5 in ambient pH levels shall not be allowed*

As shown in Table 4-10, the applicable water quality objectives for LGRP protect the habitat for aquatic life and recreational uses. Of these constituents, many are expected to be met through the proposed FAT at the AWPF, including the requirements for bacteria, dissolved oxygen, pH, turbidity, and additional chemical constituents regulated in Table 3.4 of the SF Bay Basin Plan.

Many of the constituents with water quality objectives are also regulated in the Title 22 criteria for the protection of public health. For these constituents, compliance will likely be straightforward because all of the proposed GWR portfolios include FAT, which produces a very high-quality effluent. The two remaining constituents in Table 4-10, temperature and un-ionized ammonia, require additional consideration and may need treatment and management strategies that go beyond what is required for Title 22 compliance to address and comply with these water quality objectives. For example, full oxidation of any ammonia in the AWPF may be required prior to delivery to LGRP that could be achieved with reliable nitrification in the water reclamation facility prior to the AWPF as well as with a sufficient dose (and contact time) of sodium hypochlorite in the pipeline between the AWPF and the ponds. Regarding temperature, additional studies and monitoring of the LGRP may be required to better understand the potential impact of the AWPF product water.

If it is found that significant treatment or management strategies are needed to comply with these water quality objectives, communication with the Regional Board regarding proposed strategies for compliance would be beneficial. The defined beneficial uses of the LGRP as well as the benefits of a new drinking water supply for the region will be assessed to ultimately determine the permitting approach for the selected portfolio. With regular communication with the Regional Board, negotiations regarding applicable water quality objectives may help to lower the compliance burden.

4.2.2.1.2 Water Quality Objectives for Santa Clara Subbasin

Narrative and numeric water quality objectives are also specified in the SF Bay Basin Plan to protect groundwater beneficial uses. These objectives are summarized in Table 4-11.

Table 4-11: Summary of Numeric Water Quality Objectives for the Santa Clara Subbasin

Parameter	Unit	Most Stringent Applicable Limit[a]	Associated Beneficial Use
Total Coliform	MPN/100 mL	7-day median < 1.1	Municipal Supply (MUN)
Organic and Inorganic Chemical Constituents	--	MCLs and sMCLs apply Additionally objectives may apply at the discretion of the Regional Board	Municipal Supply (MUN)
Radioactivity	--	The drinking water MCLs for radioactive constituents apply	Municipal Supply (MUN)
Taste and Odor	--	The drinking water MCLs apply	Municipal Supply (MUN)

a. *Various beneficial uses may require different water quality objectives. This table shows the most stringent requirement that must be met per the SF Bay Basin Plan.*

As shown in Table 4-11, the water quality objectives that are applicable to the Santa Clara Subbasin are focused on the protection of public health because this groundwater basin is designated a MUN. Compliance with these targets should be straightforward based on the fact that the Title 22 requirements are either equal to or more stringent than those specified in the SF Bay Basin Plan. The FAT train proposed for all of the GWR portfolios would provide significant treatment barriers that result in a high-quality AWPF product water. Due to this high degree of treatment, all portfolios are anticipated to comply with the requirements of the SF Bay Basin Plan related to protecting the Santa Clara Subbasin.

4.2.2.2 Salt and Nutrient Management Plan

Valley Water manages the Santa Clara Groundwater Subbasin, and led the development of the SNMP for the region with engagement from multiple stakeholders. The SNMP included extensive review and analysis of current and projected future groundwater quality to ensure that the existing water quality of the subbasin can be maintained as recycled water projects expand in the region. Through development of the SNMP, the current and projected future subbasin water quality was evaluated, as well as the potential assimilation capacity for salt and nutrient loading in the area. Through this work, it was determined that the water quality objectives established in the SF Bay Basin Plan for TDS, nitrate (as NO_3), and nitrate + nitrite (as N) could be adopted for the SNMP objectives to protect the Santa Clara Groundwater Subbasin. Table 4-12 summarizes the objectives.

Table 4-12. Numeric Water Quality Objectives of the Santa Clara Subbasin SNMP

Parameter	Unit	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)
TDS	mg/L	500	10,000
Nitrate	mg/L as NO3	45	--
Nitrate and nitrite	mg/L as N	10	30

LGRP allow water to percolate into the Santa Clara Groundwater Subbasin, and so the water quality objectives presented in Table 4-12 apply. Again, because all of the proposed GWR portfolios include FAT, this level of treatment will ensure that the water quality objectives for TDS, nitrate, and nitrite will be met with no additional considerations beyond what is required to protect public health. Therefore, all portfolios are anticipated to comply with the requirements of the Santa Clara Subbasin SNMP due to the high level of treatment provided by the FAT train.

4.2.2.3 California Toxics Rule

For delivery to LGRP, the AWPF product water will likely be required to comply with the CTR. The CTR establishes statewide water quality standards for inland surface waters, enclosed bays, and estuaries to protect aquatic ecosystems and human health. The rule was promulgated in 2000 by the United States Environmental Protection Agency (USEPA) as "Water Quality Standards; Establishment of Numeric Criteria for Priority Pollutants for the State of California" and updated in 2001. The numeric water quality objectives established by the CTR apply to specific categories, including freshwater habitats, saltwater habitats, and human health for the consumption of either water and organisms or organisms only. For all waters that do not include a municipal and domestic water supply beneficial use, the objectives from the 'organisms only' human health consumption category apply. These water quality objectives are applicable to water released into LGRP and must be met at the end of the discharge pipe unless a mixing zone is authorized by the Regional Board.

Many of the constituents with applicable water quality objectives in the CTR are also MCLs and sMCLs, which must be met per the Title 22 requirements for GWR projects. For these constituents, it is expected that the AWPF product water release into Los Gatos Recharge Ponds will be compliant with the CTR. Some of the constituents regulated by the CTR include water quality objectives that are lower than or in addition to Title 22 requirements. Furthermore, some constituents are grouped differently, such as THMs, where the MCL is a sum of four individual THMs but the CTR includes water quality objectives for three of the individual THMs—bromodichloromethane (BDCM), dibromochloromethane (DBCM), and bromoform[6].

Many of the water quality objectives in the CTR are easily met through the extensive treatment at the AWPF. Exceptions include constituents that can persist through FAT (both RO and UV/AOP), such as the DBPs BDCM, DBCM, and NDMA[7]. The CTR water quality objectives for these constituents at the LGRP fall under the 'organisms only' category, which is applicable because it is not designated a municipal supply. Under this designation, the water quality objective (WQO) concentrations are less stringent than the levels that should be met for all the GWR portfolios. Nevertheless, compliance with the CTR for these constituents should be considered during future phases of the design. Communication with the Regional Board may provide clarity regarding what WQOs must be met, and the preferred approach for compliance and future permitting efforts.

4.2.2.4 Anti-Degradation Policy

As described in Appendix B2 – Regulatory Framework, the State of California's policy on antidegradation is set forth in State Board Resolution 68-16[8], which establishes the following policy that requires maintenance of high-quality waters:

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[6] The water quality objectives in the CTR for BDCM, DBCM, and bromoform (organisms only, because there is not a MUN beneficial use) are 46 µg/L, 34 µg/L, and 3360 µg/L, respectively. A limit for chloroform was not promulgated in the CTR, and instead the EPA reserved the decision on stating numeric criteria. Per the CTR, "EPA intends to reassess the human health 304(a) criteria recommendation for chloroform. For these reasons, EPA has decided to reserve a decision on numeric criteria for chloroform in the CTR and not promulgate water quality criteria as proposed.

[7] Although NDMA is effectively removed through UV/AOP, reformation can occur during product water conveyance if a chloramine residual is maintained.

[8] Resolution 68-16, Statement of Policy with Respect to Maintaining High Quality Waters in California was adopted by the State Board on October 28, 1968. California's 1968 antidegradation policy predates the creation of the U.S. Environmental Protection Agency, the 1972 federal Clean Water Act, and the implementation of the federal NPDES permit program.

> *Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses of such water and will not result in water quality less than that prescribed in the policies.*

The State of California antidegradation policy (which preceded the 1972 Clean Water Act and federal antidegradation regulations) may apply to LGRP, which would require that its existing water quality be maintained unless it is demonstrated that the benefits associated with the proposed GWR project outweigh the detriments. By complying with the SF Bay Basin Plan and CTR, and based on the expected high quality of the AWPF product water release, it is anticipated that it will comply with the Anti-Degradation Policy by meeting all of the public health requirements for this project.

4.2.2.5 Chlorine Residuals Requirements

As described in Appendix B2 – Regulatory Framework, draft statewide chlorine standards currently being considered by the State Board would require that dischargers reduce the chlorine residual in water released to receiving waters to as close to zero as practicable.[9] Pending approval of statewide standards for chlorine residual in discharges, the State Board (2014) has implemented the EPA chlorine residual criteria in the current statewide NPDES permit governing discharges to surface waters from drinking water systems.[10] The EPA has established national criteria[11] for chlorine residual concentrations to protect freshwater aquatic life, including:

- CMC (1-hour) = 19 μg/L
- CCC (4-day) = 11 μg/L

Because the criteria are lower than the sensitivity of many chlorine analyzers, non-detect values from a chlorine meter are typically sufficient to satisfy the chlorine residual requirements. The need for dechlorination of the product water prior to delivery to LGRP should be discussed with the Regional Board.

4.2.2.6 Summary of Product Water Release Compliance

Based on the considerations described in the previous subsections, the relative complexity of complying with the applicable environmental requirements for each GWR portfolio is summarized in Table 4-13. Portfolios 1a, 2a, and 2b have the same relative complexity because each option involves the same approach for AWPF product water release. The SF Bay Basin Plan and CTR include some constituents that are not regulated under the Title 22 requirements, and may therefore require additional investigation into whether other treatment and/or management barriers are needed. However, it is expected that future phases of the design process can address these considerations, and so Portfolios 1a, 2a, and 2b are shaded light blue for SF Bay Basin Plan and CTR compliance.

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[9] State Water Resources Control Board (State Board). Total Residual Chlorine and Chlorine-Produced Oxidants Policy of California. 2006.

[10] State Water Resources Control Board (State Board). Order WQ 2014-0194-DWQ, General Order CAG140001, Statewide NPDES Permit for Drinking Water System Discharges to Waters of the United States. 2014.

[11] U.S. Environmental Protection Agency (EPA). National Recommended Water Quality Criteria. Located online at the EPA website at: water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm. Updated 2014.

Table 4-13. Summary of AWPF product water release regulatory complexity for each GWR portfolio

Consideration	Portfolio 1a	Portfolio 2a	Portfolio 2b	Portfolio 4
SF Bay Basin Plan	Some constituents (e.g., temperature and un-ionized ammonia) may require additional treatment and/or management barriers for compliance			Same considerations as other portfolios but added complexity due to two AWPFs
California Toxics Rule	The high-quality FAT product water is anticipated to meet these requirements			Same considerations as other portfolios but added complexity due to two AWPFs
SNMP	The high-quality FAT product water meets these requirements			
Anti-Degradation Policy	The high-quality FAT product water meets these requirements			
Chlorine Residuals Requirements	Provisions can be included to quench chlorine residuals prior to environmental release			

Portfolio 4 is expected to be more complicated when showing compliance with the SF Bay Basin Plan and CTR because two separate AWPFs will be discharging to LGRP, which may double the permitting and compliance reporting effort. For example, the Regional Board may require two separate permits for the effluents from each AWPF, and may require sampling of the combined effluents in addition to the product water from each AWPF. However, because high-quality effluent will be produced at both AWPFs and are both expected to comply with the applicable requirements, Portfolio 4 was shaded light blue for all of the environmental permitting considerations. It is important to note that communication with the Regional Board regarding applicable water quality objectives and the desired approach for complying with the regulations may help to clarify the required permitting and compliance reporting effort for this portfolio. For all portfolios, compliance with the SNMP, anti-degradation policy, and chlorine residuals requirements should be achieved without additional considerations beyond the requirements for public health protection (shaded light blue).

4.3 Summary of GWR Portfolios

4.3.1 Public Health Summary and Next Steps

A summary of the overall rankings for the four GWR portfolios is presented in Table 4-14. Based on the preliminary analysis and subsequent discussion with DDW on June 9, 2020, there were not significant differences between the GWR portfolios in terms of regulatory complexity. All of the portfolios fall mainly into the “light blue” category, which reflects the extensive experience with GWR in California.

Table 4-14. Summary of public health regulatory considerations for the groundwater recharge portfolios

	1A	2A/2B	4
Pathogens	12/10/10 with ≥ 6 months of retention time	12/10/10 with ≥ 6 months of retention time	12/10/10 with ≥ 6 months of retention time
Chemicals	FAT with no challenging source water	FAT with no challenging source water	FAT with no challenging source water
Source Control	Source control program meets the enhanced requirements specified in IPR regulations	Source control program meets the enhanced requirements specified in IPR regulations	Source control program meets the enhanced requirements specified in IPR regulations
Monitoring and Control	Proven with many precedents Less stringent with longer retention times	Proven with many precedents Less stringent with longer retention times	Proven with many precedents Less stringent with longer retention times
Retention and Response Time	≥ 6 months in the aquifer	≥ 6 months in the aquifer	≥ 6 months in the aquifer
TMF	Agencies lacking formalized interagency agreements	Agencies lacking formalized interagency agreements	Agencies lacking formalized interagency agreements

Of the six criteria, only the TMF category received a “medium blue” ranking. Efforts that could be undertaken to address this issue, i.e., to shift the rankings toward “light blue,” include:

- **Continuing to engage partners on interagency agreements**: Based on feedback from DDW, agreements that provide definition on the roles and responsibilities of the various agencies would be beneficial during assessments of TMF. The existence of such agreements may provide further evidence of the project’s ability to ensure the reliability of the potable reuse system. Topics of interest for such agreements could include defining the requirements for enhanced source control programs, the quality of the secondary or tertiary effluent that is acceptable as a feed water to the AWPF, and who is responsible for upgrades and maintenance of the system.

4.3.2 Environmental Compliance Summary and Next Steps

A summary of the overall rankings for the four GWR portfolios with regard to environmental compliance is presented in Table 4-15. In general, the portfolios are anticipated to follow existing precedents to show compliance with the product water release requirements. Consequently, most of the GWR portfolios receive “light blue” rankings for product water release. It is possible that Portfolio 4 may have increased monitoring complexity due to the presence of two AWPFs, though this may not be sufficient to increase its rankings to “medium blue.” The degree to which this will impact the portfolio should be discussed with the Regional Board at a future regulator meeting. Strategies to address any challenges with this set up should also be discussed to help guide future efforts by Valley Water and its partners.

Table 4-15. Summary of Environmental Regulatory Considerations for the Groundwater Recharge Portfolios

	1A	2A	2B	4
	Product Water Release			
SF Basin Plan				
California Toxics Rule				
SNMP				
Anti-Degradation				
Chlorine Residual				

This section will be updated to include a summary and next steps regarding ROC management approaches when final information is available.

Section 5: Surface Water Augmentation Portfolio

The SWA portfolio involves a Morgan Hill satellite treatment facility (including both wastewater treatment and an AWPF) to produce a purified effluent to recharge the Anderson Reservoir (see Table 5-1 and Figure 5-1). After retention in the reservoir, the water will be conveyed for surface water treatment at the Santa Teresa WTP. In the following sections, the SWA portfolio is evaluated based on its ability to comply with the regulatory requirements for public health (described in Section 2.1) and environmental compliance (described in Section 2.2).

Table 5-1. Key Attributes of the Morgan Hill Surface Water Augmentation Portfolios

SWA Portfolio	Design Capacity	AWPF Location	Source Supply
Morgan Hill SWA	2 mgd	Morgan Hill	Morgan Hill

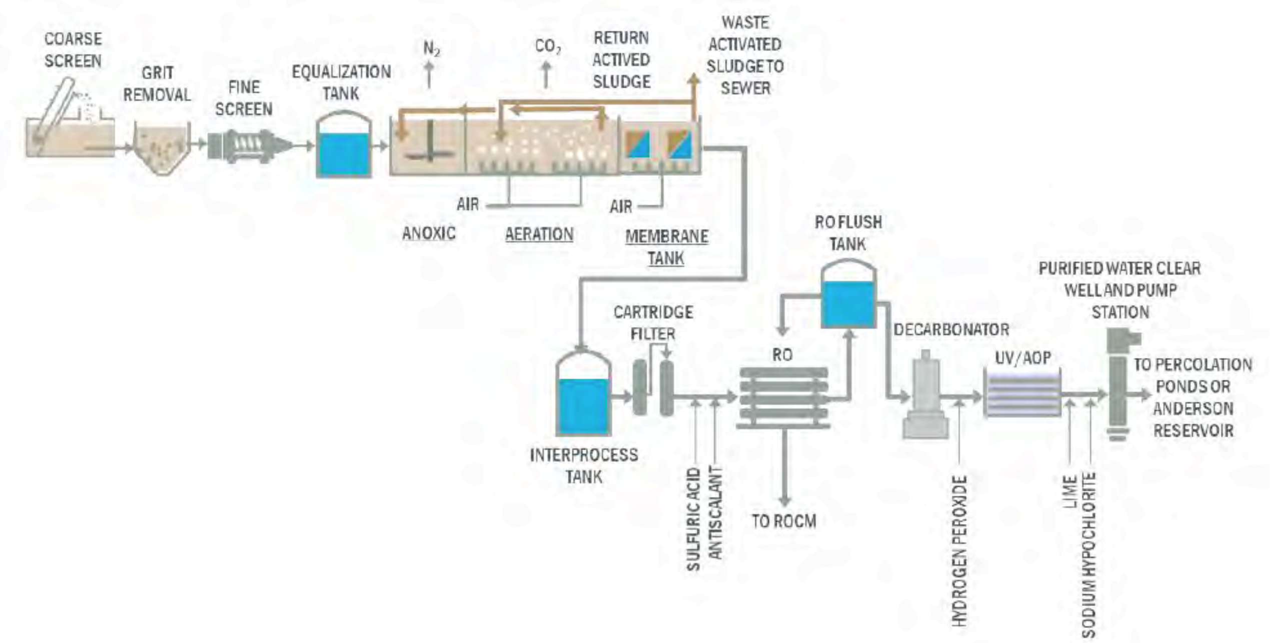

Figure 5-1. Morgan Hill satellite treatment facility process flow diagram

5.1 Public Health Criteria

5.1.1 Pathogens

The level of pathogen treatment in SWA is dependent on both the retention time and dilution provided by the reservoir (Section 2.1.2). The retention time is calculated as the volume of the reservoir divided by the total outflow of water from the reservoir. This total includes the outflow of purified water but also any other imported supply sources or runoff feeding the Anderson Reservoir. Based on an assumed operational capacity of 52,000 acre-feet (AF) for the Anderson Reservoir, the 180-day minimum retention time could be achieved as long as the outflow does not exceed 90 mgd. For the purposes of this memo, it is assumed that the Anderson Reservoir would provide no less than 180 days of retention time and no less than 100:1 dilution. Under these conditions, the AWPF treatment train would need to provide a minimum pathogen log reduction of 8/7/8. The SWA project would meet the AWPF requirements as well as the overall 12/10/10 requirements in conjunction with the Santa Teresa WTP (Table 5-2). It should be noted that the train also provides the flexibility to comply with the stricter 9/8/9 requirements for SWA projects that only provide a 10:1 minimum dilution (Section 2.1.1). Given the high degree of treatment provided at the and Anderson Reservoir, the SWA portfolio meets the “light blue” category for pathogen control (Table 5-3).

Table 5-2. Pathogen Reduction Credits Expected for the SWA portfolio

Unit Process	Virus	*Giardia*	*Cryptosporidium*
Membrane bioreactor (MBR)[a]	1.5	2	2
RO	2	2	2
UV-AOP	6	6	6
AWPF	9.5	10	10
Minimum AWPF requirements[b]	8	7	8
Santa Teresa WTP	4	3	2
Overall treatment provided	13.5	13	12
Minimum overall requirements[b]	12	10	10

a. *MBR LRV credits based on Australian WaterVal Tier 1 approach.*
b. *Assumes that the reservoir provides a minimum 180-day retention time and 100:1 dilution.*

Table 5-3. Regulatory Considerations for Pathogen Control in the Surface Water Augmentation Portfolio

Morgan Hill SWA
12/10/10 with 6 month retention time and 100:1 dilution

5.1.2 Chemicals

From the perspective of public health requirements, both GWR and SWA have similar requirements for the control of toxic chemicals. Section 4.1.2 described the well-documented ability of the FAT train to protect against the large diversity of chemical compounds of concern for potable reuse applications. Given the similarity of the SWA treatment train to the GWR trains, the SWA portfolio meets the “light blue” category for chemical control (Table 5-4).

Table 5-4. Regulatory Considerations for Chemical Control in the Surface Water Augmentation Portfolio

Morgan Hill SWA
FAT treatment with no challenging source water

5.1.3 Source Control

It is assumed that SCRWA would continue to administer the source control program for the SWA Portfolio. Implementing an expanded source control program for this portfolio is facilitated by the fact that an existing program is in place and is completely within the jurisdiction of a single project partner. Furthermore, source control programs have been established for other SWA projects providing greater regulatory clarity. Based on this evaluation, the SWA Portfolio falls into the “light blue” category (low difficulty) for source control assuming that the program would be enhanced to comply with the SWA requirements (Table 5-5). As discussed in Section 2.1, formal interagency agreements describing source control responsibilities are not required under the SWA regulation. The presence or absence of such agreements was not used to evaluate the SWA Portfolio from a regulatory point of view, though such agreements are likely to be important from an institutional perspective.

Table 5-5. Regulatory Considerations for Source Control in the Surface Water Augmentation Portfolio

Morgan Hill SWA
Source control program meets the enhanced requirements specified in IPR regulations

5.1.4 Monitoring and Control

While the monitoring and control of the AWPF may be straightforward, the SWA portfolio involves augmenting a reservoir that is a source of feed water for the downstream Santa Teresa WTP. Any issues that impact the purified water’s compliance with the SWA regulations may therefore lead to consequences for the WTP, including the need to switch to alternative sources of water. The dependence of the facility on AWPF performance requires additional coordination and control between the AWPF, reservoir operations, and the downstream WTP in the form of a Joint Plan, as specified in Section 60320.301 of the SWA regulation. This project would benefit from the precedents set by the two San Diego region SWA projects, both of which augment reservoirs that are treated at a single downstream surface water treatment plant. While a formal Joint Plan is required by DDW, they expressed during the June 9, 2020 meeting that the requirements for monitoring and control would be similar for GWR. Given this feedback, the SWA project falls into the “light blue” category for monitoring and control (Table 5-6). Note that expanding the project to provide a source water for multiple end uses (e.g., multiple water treatment plants and/or groundwater recharge basins) will introduce greater complexity and may require a higher number of permits. Pursuing such a configuration may result in the project entering the “medium blue” category.

Table 5-6. Regulatory Considerations for Monitoring and Control in the Surface Water Augmentation Portfolio

Morgan Hill SWA
Single agency overseeing WW/AWTF and DW with > 100:1 dilution at a single end use location

5.1.5 Retention and Response Time

As described in Section 5.1.1, it is assumed that the reservoir will provide greater than 180 days of theoretical retention time and no less than 100:1 dilution of a 24-hour pulse of off-spec water. This is based on the assumption that the reservoir will operate at its recent operational maximum volume of 52,000 AF and will not have outflows exceeding 90 mgd[12]. In meeting these theoretical retention time and dilution requirements, the project falls into the most conservative operational regime described by the regulation. Based on this evaluation, the SWA Portfolio falls into the “light blue” category (low difficulty) for retention and response time (Table 5-7).

Table 5-7. Regulatory Considerations for Retention and Response Time in the Surface Water Augmentation Portfolio

Morgan Hill SWA
> 120-d of theoretical retention time in the reservoir

5.1.6 TMF Capacity

DDW will require that agencies pursuing SWA possess the TMF capacity to build, maintain, monitor, and operate potable reuse projects. The TMF requirements increase with the complexity and sophistication of the system, which may be assessed based on the number and types of processes, monitoring methods, and the number of control points. Based on preliminary feedback from DDW at the June 9, 2020 meeting, they do not believe that a demonstration facility would be necessary to support Valley Water’s TMF evaluation, assuming that the project is not proposing to include new elements that fall outside of the regulations. While this feedback is preliminary, it provides initial reassurance that SWA will not pose a significant additional hurdle for technical capacity than GWR.

As with GWR, DDW will likely look at the existence of agreements between partner agencies during their evaluation of TMF to understand how the project will ensure reliability. At this time, interagency agreements that define the roles and responsibilities of the partners have not yet been completed. Consequently, the portfolios have been assigned a preliminary ranking in the “medium blue” category to account for this (Table 5-8).

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[12] Currently, the Anderson Reservoir is undergoing a seismic retrofit project to improve its reliability and safety while restoring the reservoir to its original capacity of 89,000 AF. Greater capacity will increase retention time and will likely increase dilution as well.

Table 5 8. Regulatory Considerations for TMF Capacity in the Surface Water Augmentation Portfolio

Morgan Hill SWA
Agencies lacking formalized interagency agreements

To address the TMF requirements for this portfolio, the following next step is recommended:

- **Continue to engage partners on interagency agreements**: Based on feedback from DDW during the June 9, 2020 meeting, agreements that provide definition on the roles and responsibilities of the various agencies would be beneficial during DDW's assessment of TMF. The existence of such agreements provides further evidence of the project's ability to ensure the reliability of the potable reuse system. A major topic of interest for such agreements includes defining the requirements for enhanced source control programs.

As stated in the Monitoring and Control discussion (Section 5.1.4), expanding the project to provide a source water for multiple end uses (e.g., multiple water treatment plants and/or groundwater recharge basins) will introduce greater complexity and require additional coordination and permitting. Pursuing this configuration may cause the project to enter the "dark blue" category.

5.2 Environmental Compliance Criteria

The proposed AWPF at Morgan Hill will produce an ROC and a purified water that must meet environmental requirements. The following subsections describe the approaches and regulatory considerations related to ROC management and product water release for the SWA portfolio.

5.2.1 RO Concentrate Management

The SWA portfolio involves an AWPF at Morgan Hill, with feedwater to the satellite wastewater facility sourced from the Morgan Hill trunk sewer.

This section will be updated when the ROC management approaches have been finalized.

5.2.2 Product Water Release

The proposed SWA portfolio involves the delivery of AWPF product water to Anderson Reservoir, which is currently used by Valley Water as a municipal drinking water source. Anderson Reservoir has designated beneficial uses in the SF Bay Basin Plan that include the full spectrum of use categories—human consumption, aquatic and wildlife habitat, and recreation. With these beneficial uses, a number of environmental regulations are applicable to preserve the defined uses. The following subsections describe the key aspects of the applicable environmental regulations that may impact AWPF product water release compliance.

5.2.2.1 SF Bay Basin Plan

Anderson Reservoir has the following designated uses per the SF Bay Basin Plan:

- MUN
- GWR
- COMM
- COLD

- SPWN
- WARM
- WILD
- REC-1
- REC-2

Beneficial uses related to human consumption and aquatic life have additional water quality objectives that are defined by the CTR. Because Anderson Reservoir is listed as a municipal and domestic supply, all of the water quality objectives associated with this use are applicable per the SF Bay Basin Plan and the CTR.

Narrative water quality objectives are included in the SF Bay Basin plan for bioaccumulation, biostimulatory substances, color, floating materials, oil and grease, population and community ecology, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, and toxicity. In general, the narrative water quality objectives specify that constituents not be present at levels that cause nuisance or adversely affect beneficial uses. Table 5-9 provides a summary of the numeric water quality objectives that are applicable to Anderson Reservoir.

Table 5-9. Numeric Water Quality Objectives for Anderson Reservoir

Parameter	Unit	Most Stringent Applicable Limit[a]	Associated Beneficial Use
Fecal Coliform	MPN/100 mL	Geometric mean < 20	Municipal Supply (MUN)
Total Coliform	MPN/100 mL	Geometric mean < 100	Municipal Supply (MUN)
Enterococcus	MPN/100 mL	Geometric mean < 35 No Sample > 104	Water Contact Recreation (REC-1)[b]
Dissolved Oxygen	mg/L	≥ 7.0[c]	Cold water habitat (COLD)
pH	--	6.0 – 8.5[d]	Applicable to all surface waters in the SF Bay Basin Plan
Radioactivity	mg/L	The drinking water MCLs for radioactive constituents apply	Municipal Supply (MUN)
Temperature	˚F (˚ C)	Change from natural receiving water temperature ≤ 5 (2.8)	Applicable to all surface waters in the SF Bay Basin Plan
Turbidity	NTU	< 10% change for waters with natural turbidity > 50 NTU	Applicable to all surface waters in the SF Bay Basin Plan
Un-ionized Ammonia	mg/L	Receiving Water Concentrations: Annual Median = < 0.025 mg/L Maximum = 0.4 mg/L	Median applicable to all surface waters in the SF Bay Basin Plan, maximum applicable to water bodies in the Lower Bay
Chemical Constituents	--	See Tables 3.4 and 3.5 in the SF Bay Basin Plan The drinking water MCLs and sMCLs apply	Applicable to all surface waters in the SF Bay Basin Plan. MCLs and sMCLs apply to Municipal Supply (MUN) beneficial use

a. *Various beneficial uses may require different water quality objectives. This table shows the most stringent requirement that must be met per the SF Bay Basin Plan.*

b. *Although water contact recreation is not allowed in Anderson Reservoir, the SF Bay Basin Plan notes that the associated water quality objectives still apply.*

c. *The median dissolved oxygen concentration for any three consecutive months shall not be less than 80 percent of the dissolved oxygen content at saturation.*

d. *pH changes greater than 0.5 in ambient pH levels shall not be allowed*

Many of the constituents with applicable water quality objectives in the SF Bay Basin Plan are also regulated via the Title 22 requirements for GWR projects. For these constituents, the SF Bay Basin Plan water quality objectives will be met with the level of treatment and management needed to protect public health. These constituents include radioactivity, turbidity, MCLs, and sMCLs. Additionally, the SF Bay Basin Plan requirements for other constituents will be met by meeting the Title 22 requirements, including for bacteria and pH.

Some constituents have stricter water quality objectives per the SF Bay Basin Plan, including some metals, dissolved oxygen, temperature, and un-ionized ammonia. For these constituents, an assessment of the anticipated AWPF product water quality and the ability to comply with these additional requirements will be needed. In general, many constituents will be effectively removed by the treatment train proposed for this SWA portfolio. Ozone followed by BAC will provide an initial organics barrier, and RO followed by UV/AOP will reduce many of the remaining constituents of concern. This treatment train will provide a strong barrier against metals, and so compliance with the additional water quality objectives for metals is anticipated without the need for additional treatment. Considering dissolved oxygen, the unit processes will both remove organics and introduce dissolved oxygen into the product stream. It is anticipated that this water quality objective will be met without additional treatment. Similarly, free chlorine will be used in the pipeline between the AWPF and Anderson Reservoir, which will oxidize any remaining ammonia in the water; thus, compliance with the un-ionized ammonia water quality objective is anticipated with the current AWPF design. Finally, although the temperature of the AWPF water will likely be warmer than Anderson Reservoir, the significant amount of dilution provided in the reservoir is anticipated to be sufficient for meeting the temperature water quality objective. Nevertheless, the temperature impact may need to be confirmed through future hydrodynamic modeling.

Although it is anticipated that all applicable water quality objectives will be met with the proposed AWPF treatment train, monitoring and reporting of the reservoir conditions before and after AWPF product water is introduced will still be required per Title 22 requirements and the SF Bay Basin Plan. Additionally, confirmation from the Regional Board regarding applicable water quality objectives would provide clear guidance for future permitting efforts.

5.2.2.2 California Toxics Rule

The CTR will likely be applicable for delivery of AWPF product water to Anderson Reservoir. The water will be subject to the water quality standards defined in the CTR, which must be met at the end of the discharge pipe unless a mixing zone is authorized by the Regional Board. Unlike the GWR portfolios that release AWPF product water into LGRP, the drinking water reservoir has a designated beneficial use of municipal and domestic supply. Because of this designation, the water quality objectives in the CTR for human health and consumption of both water and organisms apply.

Many of the constituents included in the CTR are already regulated per the Title 22 regulations for SWA; however, some constituents have stricter requirements per the CTR. The constituents of highest concern for achieving compliance with the CTR due to their persistence through FAT (both RO and UV/AOP) are the THMs BDCM and DBCM, and NDMA. BDCM and DBCM are disinfection byproducts that can form when naturally occurring organic matter and bromide (i.e., organic and inorganic precursors) in the water react with free chlorine during disinfection. In drinking water, THMs are regulated under the Disinfection Byproducts Rules by the sum of chloroform, BDCM, DBCM, and bromoform known as total trihalomethanes (TTHM). The MCL for TTHM is 80 µg/L. Under the CTR, THMs are regulated individually, with unique numerical criteria for each compound. The CTR limits for BDCM and DBCM are 0.56 µg/L and 0.41 µg/L, i.e., approximately two orders of magnitude lower than the MCL. Similarly, CTR limits for NDMA are 0.069 ng/L, more than two orders of magnitude lower than the NL of 10 ng/L.

Due to these significantly stricter requirements, additional treatment and/or management barriers may be required to comply with the water quality objectives. Strategies employed by the two San Diego region SWA projects to control these chemicals could be leveraged to minimize DBP formation. It may also be beneficial to discuss the requirements with the Regional Board to confirm what water quality objectives are applicable and to develop potential strategies and permitting approaches that can ensure compliance.

5.2.2.3 Anti-Degradation Policy

Similar to the GWR portfolios, the Anti-Degradation Policy applies to Anderson Reservoir, and requires that its existing water quality be maintained unless it is demonstrated that the benefits associated with the proposed SWA project outweigh the detriments. Based on the expected high quality of the AWPF product water, it is anticipated that it will comply with the Anti-Degradation Policy by meeting all of the environmental and public health requirements for this project.

5.2.2.4 Chlorine Residuals Requirements

Similar to the GWR portfolios, release to Anderson Reservoir would be required to comply with the EPA's established chlorine residuals requirements. Although the proposed treatment includes free chlorine disinfection of the AWPF product water, a dechlorination facility can be provided to dose sodium bisulfite to ensure that the product water is dechlorinated prior to release into Anderson Reservoir.

5.2.2.5 Summary of Product Water Release Compliance

The environmental regulations applicable to the AWPF product water release for the SWA Portfolio were discussed in this section. To summarize the relative difficulty of complying with each applicable environmental regulation, Table 5-10 includes color-coded shading, where light blue indicates no additional analysis or treatment is anticipated to comply and medium blue denotes the potential for additional work being needed to ensure compliance. As described in the previous sub-sections, the majority of the relevant requirements and water quality objectives will be met with the proposed AWPF treatment train. Only the CTR may impose treatment requirements that would require additional consideration that should be addressed in future permitting efforts. To address the potential compliance challenges associated with the CTR, discussions with the Regional Board may provide guidance for future steps in the permitting effort and help to better define what will be required for future implementation of this portfolio.

Table 5-10. Summary of AWPF Product Water Release Regulatory Complexity for the SWA portfolio

Consideration	Morgan Hill SWA
SF Bay Basin Plan	The high-quality AWPF product water meets these requirements
California Toxics Rule	Some WQOs are more restrictive than public health requirements and may require additional considerations for compliance
Anti-Degradation Policy	The high-quality AWPF product water meets these requirements
Chlorine Residuals Requirements	Provisions can be included to quench chlorine residuals prior to release

5.3 Summary of SWA Portfolio

5.3.1 Public Health Summary and Next Steps

A summary of the overall rankings for the SWA portfolio is presented in Table 5-11. The SWA portfolio falls primarily into the "light blue" category to reflect the fact that it is pursuing the conservative end of the SWA regulations and following a similar approach to the San Diego region SWA projects. Nevertheless, this project would be one of the first five projects to pursue SWA in California, which adds a layer of uncertainty compared to the GWR projects.

Table 5-11. Summary of Public Health Regulatory Considerations for the Surface Water Augmentation Portfolio

	Morgan Hill SWA
Pathogens	12/10/10 with 6-month retention time and 100:1 dilution
Chemicals	FAT treatment with no challenging source water
Source Control	Source control program meets the enhanced requirements specified in IPR regulations
Monitoring and Control	Single agency overseeing WW/AWPF and drinking water with > 100:1 dilution at a single end use location
Retention and Response Time	> 120 days of theoretical retention time in the reservoir
TMF	Agencies lacking formalized interagency agreements

Topics of interest for future efforts include:

- **Monitoring and control**: Continue to develop the operational scenarios for the SWA project to understand if purified water from the Anderson Reservoir will be sent to other locations in addition to Santa Teresa WTP. This scenario will increase the complexity of the system—including modifications to the Joint Plan—and may present additional challenges. Per DDW feedback at the June 9, 2020 meeting, these challenges would not be insurmountable, but should be included in the evaluation of regulatory compliance.
- **Continue to engage partners on interagency agreements**: Securing interagency agreements can provide further evidence of the project's ability to ensure the reliability of the potable reuse system. One recent example of a governance structure created to support a regional potable reuse project is the joint powers authority (JPA) that was formed between Padre Dam Municipal Water District, the City of El Cajon, and the County of San Diego in support of the ECAWP project. The JPA creates a new public agency with the authority to plan for, design, construct, own, lease, operate, maintain, repair, and replace the ECAWP project; receive, convey, treat, and dispose of wastewater; produce and deliver product water and Title 22 water; and perform services or assume obligations of the Member Agencies and non-Member Agencies specifically related to the ECAWP project.

5.3.2 Environmental Compliance Summary and Next Steps

A summary of the overall rankings for the SWA portfolio with regard to environmental compliance is presented in Table 5-12. Based on the permitting experience of San Diego's North City Pure Water project, the product water release requirements should be largely straightforward. Given the municipal designation of the Anderson Reservoir, there are certain constituents that will have stricter environmental discharge requirements than those present on the public health side. This is particularly true for a number of DBPs, including DBCM, DCBM, and NDMA. Discussions with the Regional Board are recommended to confirm that these low targets must be met, and to discuss options for achieving compliance either through dilution crediting or treatment.

Table 5-12. Summary of Environmental Compliance Regulatory Considerations for the SWA Portfolio

	SWA
	Morgan Hill
	Product Water Release
SF Basin Plan	░
California Toxics Rule	▒
SNMP	N/A
Anti-Degradation	░
Chlorine Residual	░

This section will be updated when the ROC management approaches have been finalized.

Section 6: Raw and Treated Water Augmentation Portfolios

6.1 Public Health Criteria

The DPR portfolios include both RWA and TWA options that use the same wastewater supplies as the GWR options to supply feedwaters to the AWPFs. All of the DPR portfolios build off the FAT train used for GWR but include enhancements to address the DPR considerations described in Section 3. The process flow diagrams for the RWA and TWA trains are show on Figures 6-1 and 6-2. The design capacities and yields of the portfolios are shown in Table 6-1.

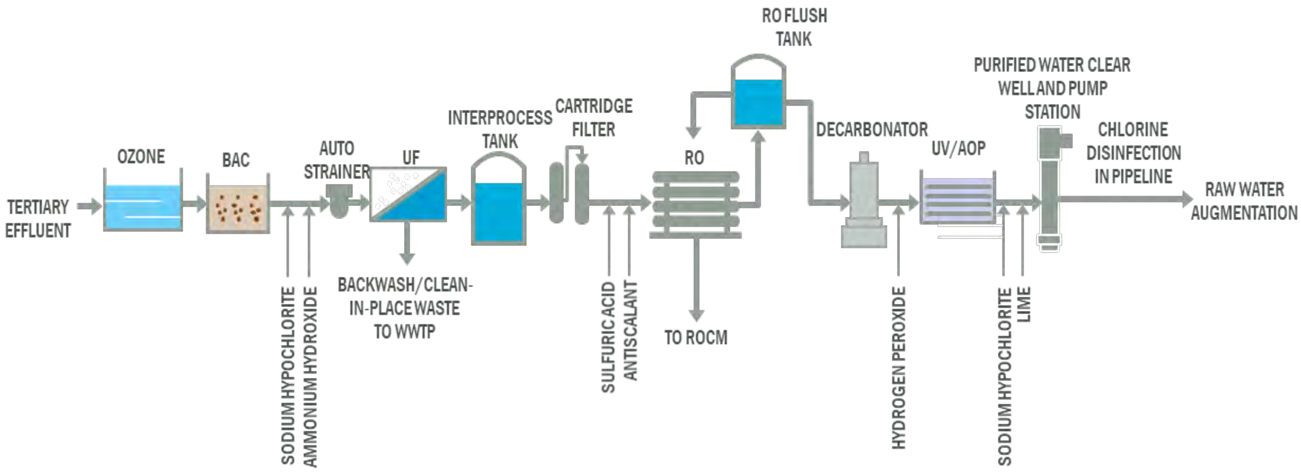


Figure 6-1. Proposed AWPF treatment train for the raw water augmentation portfolio

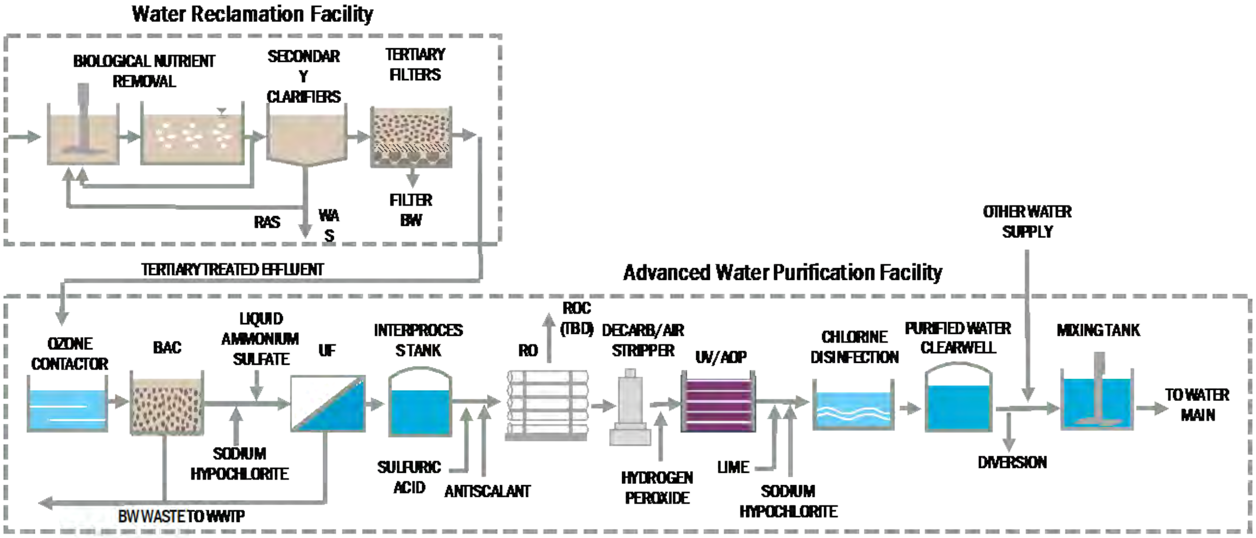


Figure 6-2. Proposed AWPF treatment train for the treated water augmentation portfolios

Table 6-1. Key Attributes of the Four RWA and TWA Recharge Portfolios

DPR Portfolio	Design Capacity (mgd)	AWPF Location	Source Supply	Delivery Point
Portfolio 1b RWA	24 mgd	Adjacent to SVAWPC	SJ/SC RWF	Penitencia WTP
Portfolio 1c TWA	24 mgd	Adjacent to SVAWPC	SJ/SC RWF	Up to 24 mgd to Milpitas Pipeline 4 mgd local delivery to City of San José and City of Santa Clara
Portfolio 1d TWA	24 mgd	Adjacent to SVAWPC	SJ/SC RWF	Up to 24 mgd to modulating valve vault at Penitencia WTP 4 mgd local delivery to City of San José and City of Santa Clara
West County TWA	24 mgd	Los Altos Treatment Plant	PA RWQCP and SV WPCP	West Pipeline

In the following sections, the four portfolios are evaluated based on their ability to comply with the regulatory requirements for public health (described in Section 2.1) and environmental compliance (described in Section 2.2). Because the TWA portfolios use the same treatment train, they are discussed collectively except to note any relevant portfolio-specific differences.

6.1.1 Pathogens

6.1.1.1 Portfolio 1b RWA

While RWA pathogen control criteria are still in development, the regulations are expected to be more stringent than IPR to account for the lost benefits of the environmental buffer. The addition of O_3/BAC pre-treatment increases pathogen control and redundancy, allowing the RWA train to exceed the anticipated pathogen reduction requirements (Table 6-2). The redundancy beyond the anticipated requirements for all pathogens will also allow for greater operational flexibility to deal with excursions.

Table 6-2. Pathogen Reduction Credits Expected for the Raw Water Augmentation Train

	Virus	*Giardia*	*Cryptosporidium*
Tertiary Treatment[a]	0.4	0.2	0
O_3/BAC	6	6	1
MF	0	4	4
RO	2	2	2
UV-AOP	6	6	6
Free Cl_2	6	1	0
AWPF without surface water treatment plant	**20.4**	**19.2**	**13**
Surface Water Treatment Plant [b]	4	3	2
Total with surface water treatment plant	**24.4**	**22.2**	**15**
Anticipated Requirements	**15**	**13**	**13**

a. *Tertiary effluent, having undergone secondary treatment, would be provided from the WWTPs. The credits in this row are associated with the secondary processes.*

b. *It is not clear whether the State Water Board will provide the default 4/3/2 credits for surface water treatment plants without studies demonstrating the effectiveness of the plant in the treatment of FAT effluents.*

It should be noted that the State Board has not provided clear definition regarding how they will credit the surface water treatment plants in RWA settings. Their most recent written communication implies that the default 4/3/2 credits should not be assumed, and that site-specific testing may be required to demonstrate performance and assign specific LRV credits (SWRCB 2019). During the June 9, 2020 meeting with DDW, the State board confirmed that this additional effort may require studies evaluating pathogen reduction through the treatment processes, and the correlation of surrogate parameters to process performance.

In the absence of water treatment plant credit, the train provides no redundancy for *Cryptosporidium* beyond the anticipated 13-log reduction requirement. In this case, additional efforts to enhance credit at the WWTP or AWPF, such as through a pathogen monitoring study or enhanced RO crediting, may be needed. This redundancy may be worth pursuing to provide greater flexibility for AWPF operations. In the absence of redundancy, excursions that cause any of the processes to drop below the stated *Cryptosporidium* reduction levels would require diversion of the resulting off-spec water.

6.1.1.2 TWA Portfolios

TWA is expected to require pathogen control that is at least as stringent as RWA. While an additional unit process (air stripping) has been added to the TWA train, it does not provide credit for pathogen reduction. Consequently, higher credits will need to be sought for the individual unit processes in the TWA trains to provide pathogen redundancy. As with the RWA train, *Cryptosporidium* is the pathogen driving the regulatory discussion because it provides the least amount of redundancy. For TWA, both a pathogen monitoring study and enhanced RO monitoring could be used to provide redundancy for *Cryptosporidium* control. The anticipated pathogen reduction for the TWA trains is provided in Table 6-3.

Table 6-3. Pathogen Reduction Credits Expected for the Treated Water Augmentation Train

	Virus	*Giardia*	*Cryptosporidium*
Tertiary Treatment[a]	0.5	0.5	0.5
O3/BAC	6	6	1
MF	0	4	4
RO[b]	2.5	2.5	2.5
UV-AOP	6	6	6
Air stripping	0	0	0
Free Cl_2	6	1	0
AWPF Total	21	20	14
Anticipated requirements	15	13	13

a. *Assumes pathogen monitoring study is performed at the wastewater treatment plant from raw through tertiary treatment to obtain higher pathogen credit. Higher credits beyond the conservative 0.5-log values shown may be possible.*

b. *Assumes enhanced monitoring used (e.g., strontium) to obtain higher credits for RO performance.*

6.1.1.3 Pathogen Control Summary and Next Steps

Based on the scoring rubric described in Table 3-2 in Section 3.7, both the RWA and TWA trains fall into the "light blue" category by meeting the anticipated 15/13/13 requirements (Table 6-4).

Table 6-1. Regulatory Considerations for Pathogen Control in the RWA And TWA Portfolios

1B RWA	1C TWA	1D TWA
≥15/13/13	≥15/13/13	≥15/13/13

Recommended next steps for pathogen control include:

- **Pathogen monitoring study**: Assuming additional credit will be required for the TWA portfolios, pathogen monitoring studies may be needed to obtain more extensive pathogen credits through the RWF. Currently the State Board is sponsoring research to develop methods for the sampling of pathogens in wastewater matrices. Findings from this effort—including SOPs—should be leveraged during the development of the test plan, and all efforts should be undertaken in conjunction with both DDW and the Independent Advisory Panel (IAP).
- **Enhanced RO crediting**: In lieu of investing in additional pathogen control barriers, higher credits can be sought to increase redundancy. DDW has approved enhanced RO crediting (beyond the traditional credits assigned with electroconductivity and TOC monitoring) for the first time in San Diego's Title 22 Engineering Report for the augmentation of the Miramar Reservoir. The City will use the monitoring of

strontium—an inorganic species present in the wastewater—to conservatively achieve 3-log reduction credit for RO. Based on testing at the City's demonstration Pure Water Facility, it is anticipated that credits of 3.5-log or higher will be routinely demonstrated.

- Surface water treatment plant crediting: The fate of the surface water treatment plant remains uncertain for RWA projects based on DDW's comments in the second edition of the DPR Regulatory Framework. Evidence of their continued interest in this topic includes the State Board's sponsoring of WRF project 5049, "Benefits and Challenges in Pathogen Removal When Blending Advanced Treated Water with Raw Water Upstream of a Surface Water Treatment Plant in DPR." Participation in this project or other similar efforts may be useful to help drive the regulatory conversation and argue for the inclusion of surface water treatment plant credits in RWA scenarios.

6.1.2 Chemicals

6.1.2.1 Portfolio 1b RWA

As described in Section 3, O_3/BAC has been shown to control of both chemical peaks and low-molecular-weight, unknown contaminants. In addition to these barriers at the AWPF, the RWA scheme relies on a number of other barriers to reduce the concentration of toxic chemicals, including enhanced source control, a high-quality feed water that has undergone both biological nutrient removal and tertiary filtration, and blending with other source water, and treatment at the surface water treatment plant.

6.1.2.2 TWA Portfolios

The TWA train incorporates air stripping as an additional layer of protection against chemicals. This barrier helps compensate for the reduction in blending and the loss of the downstream drinking water treatment plant in the TWA portfolios. Air stripping adds to the train's robustness by enhancing the volatilization of VOCs. The air stripping has been designed to provide >90 percent removal of THM, a volatile DBP commonly found in AWPF effluents, though it is also intended to control other volatile chemicals, both known and unknown. Decarbonators are included in the TWA treatment train to provide both air stripping for VOC removal and pH adjustment.

While temperature is a consideration for DPR, the need for temperature control should be considered on a case-by-case basis. The treated surface water from Penitencia and Rinconada WTPs is very close in temperature to the WW effluent from SJ/SC RWF. In these TWA portfolios, the temperature difference was about 1 to 2 degrees Fahrenheit, which did not indicate a need specifically for temperature reduction.

6.1.2.3 Chemical Control Summary and Next Steps

Based on the scoring rubric described in Table 3-2 in Section 3.7, the RWA and TWA trains fall into the "light blue" and "medium blue" categories, respectively (Table 6-5). The RWA train is assigned a higher ranking due to the fact that it provides a wider set of barriers against toxic chemicals than the TWA options, including downstream treatment at the Penitencia WTP and blending. Because the requirements for chemical control in DPR remain undetermined, an approach with a broader set of barriers may be easier to permit.

Table 6-2. Regulatory Considerations for Chemical Control in the RWA And TWA Portfolios

1B RWA	1C TWA	1D TWA
High-quality WW to FAT train with enhanced robustness and multiple additional barriers	High-quality WW to FAT train with enhanced robustness and moderate additional barriers	High-quality WW to FAT train with enhanced robustness and moderate additional barriers

Recommended next steps for chemical control include:

- **Track the recommendations from the State Board's DPR-4 Research Project**: The State Board is currently supporting the DPR-4 research effort to understand the requirements to control chemical peaks and unknown contaminants. Findings from this effort are expected in the near future (by summer of 2020). Based on DDW's interaction with the DPR-4 team, they are likely to have further defined what requirements they will impose on DPR trains for chemical control.
- **Develop additional blending analysis:** The State Board is likely to be interested in understanding the extent of blending that the DPR projects will provide. Additional efforts to characterize how much blending occurs at different locations (spatial) in the distribution system and at different times of the day or the year (temporal) will likely be valuable for future DDW interactions. Per feedback from DDW at the June 9, 2020 meeting, they do not anticipate that there will be a blending requirement for TWA scenarios. Consequently, the fact that Portfolio 1c provides minimal to no blending at some points of the distribution system should not impact its feasibility.

6.1.3 Source Control

Given the uncertainty in the future requirements for the enhancements needed for DPR source control programs and the lack of additional direction from DDW during the June 9, 2020 meeting, all portfolios were assigned the "medium blue" scoring (Table 6-6), as described in Table 3-2. This scoring was assigned under the assumption that all the portfolios would be able to make the necessary enhancements to meet the stringent future source control requirements. Next steps for this topic include staying abreast of the findings from the State Water Board's source control panel when they are released later this year. This report is likely to influence the State Board's future source control requirements, and so it can be used to understand what the future modifications to source control might require.

Table 6-3. Regulatory Considerations for Source Control in the RWA and TWA Portfolios

1B RWA	1C TWA	1D TWA
Source control program likely to meet the enhanced requirements specified in future DPR regulations	Source control program likely to meet the enhanced requirements specified in future DPR regulations	Source control program likely to meet the enhanced requirements specified in future DPR regulations

6.1.4 Monitoring and Control

6.1.4.1 Portfolio 1b RWA

While an enhanced monitoring and control system will be a critical feature of all DPR systems, the requirements for any given portfolio must also take into account other barriers. In the RWA portfolio 1b, a number of additional barriers have been provided that reduce the system's reliance on monitoring and control for public health protection. These barriers include:

- Pathogen control with a high degree of redundancy
- Robustness against chemicals with the addition of O_3/BAC pre-treatment
- Retention time in the pipeline and 3-MG purified water tank near Penitencia WTP

- Blending of purified water with other potable source waters
- Source control program meeting DPR requirements

The monitoring and control system for RWA will require significant enhancements over the GWR portfolios, but the stringency required is balanced by the system's multiple, additional barriers. Consequently, the RWA portfolio receives the "medium blue" ranking for DPR monitoring and control.

Note that this ranking assumes that the purified water serves as a source water to the Penitencia WTP alone. Distributing the purified water to additional water treatment plants or the LGRP via the Central Pipeline may significantly increase the complexity of the control and coordination needed for the system.

6.1.4.2 TWA Portfolios 1c and 1d

Compared to the RWA portfolio, the TWA portfolios provide a lower degree of pathogen redundancy, meaning that the system will be *more* reliant on failure response to protect public health. This will likely increase the degree of monitoring and control of these systems compared to RWA. The barriers provided by the TWA trains that will impact their requirements for monitoring and control include:

- Pathogen control with a moderate degree of redundancy
- Robustness against chemicals with the addition of O_3/BAC pre-treatment and air stripping
- Retention time in the baffled clearwell of the AWPF providing 8 hours of response time
- Source control program meeting DPR requirements

One element that differentiates TWA portfolios 1c and 1d is the degree of available blending with other source waters. In certain parts of the distribution system, Portfolio 1c will provide minimal to no blending, particularly at the initial turnouts downstream of the tie-in to the Milpitas Pipeline. As the water travels down the pipeline and approaches the Penitencia WTP it will blend with the potable supplies from the WTP. The degree of blending available for local delivery to the cities of San José and Santa Clara remains unclear. Portfolio 1d, however, includes blending with other treated water supplies at the mixing vault near Penitencia WTP. As a result, Portfolio 1c may need a greater degree of monitoring and control than 1d. While the system may need to adapt to account for lower degrees of blending, DDW clarified at the June 9, 2020 meeting that blending is unlikely to be a requirement for TWA projects, maintaining the feasibility of projects like Portfolio 1c that may provide no blending. DDW also clarified that purified water in TWA applications that connect directly to the distribution system will be viewed as potable water supply, similar to incorporating other potable water supplies. However, some degree of treated water blending may still be considered beneficial in terms of corrosion control, aesthetics, and environmental justice.

Based on this discussion, Portfolio 1c and 1d fall into the "dark blue" and "medium blue" categories for monitoring and control requirements, respectively.

6.1.4.3 Monitoring and Control Summary and Next Steps

Based on the scoring in Table 6-7, the DPR portfolios receive either "medium blue" or "dark blue" rankings for monitoring and control.

Table 6-4. Regulatory Considerations for Monitoring and Control in the RWA and TWA Portfolios

1B RWA	1C TWA	1D TWA
Enhanced control system with *multiple* additional barriers (treatment, blending, retention)	Enhanced control system with *moderate* number of additional barriers	Enhanced control system with *multiple* additional barriers (treatment, blending, retention)

Recommended next steps for monitoring and control include:

- **Engage in WRF research project 4954**: Valley Water is currently an agency partner on WRF Project 4954 “Integration of High Frequency Performance Data for Microbial and Contaminant Control in Potable Reuse Treatment Systems” that seeks to develop and test a system for the rapid detection and response to failures. Findings from this study will likely provide useful information for future DPR demonstration testing at Valley Water and other agencies interested in DPR.
- **DPR demonstration testing:** The first agencies to pursue DPR projects will likely pursue testing to demonstrate their projects’ ability to protect public health. Whether such testing will be a requirement in the future regulations is unclear, though such investments are often made to build support for the project with the regulators, public, IAP, and other stakeholders. Demonstration testing provides an excellent opportunity to develop and evaluate a DPR monitoring and control system.

6.1.5 Retention and Response Time

6.1.5.1 Portfolio 1b RWA

Portfolio 1b provides retention time prior to distribution in the conveyance infrastructure, in the 3-MG purified water tank, and through treatment in the Penitencia WTP. Based on a flowrate of 24 mgd, this infrastructure should provide more than 8 hours of retention time to initiate failure responses. Based on this evaluation, Portfolio 1b achieves the “medium blue” ranking for retention and response time.

6.1.5.2 TWA Portfolios

All of the TWA portfolios include an 8-hour baffled clearwell to provide time to respond to upstream treatment issues. This clearwell also provides hydraulic buffering to help manage demands in the distribution system and a location from which to divert off-spec water prior to distribution.

6.1.5.3 Retention and Response Time Summary and Next Steps

Based on the scoring in Table 6-8, the DPR portfolios receive “medium blue” rankings for retention and response time. Future efforts should seek to demonstrate that this level of retention time—in conjunction with the enhanced monitoring and control system—can detect and respond to any excursions or failures that occur at the AWPF. The findings from such an effort could be used to justify providing shorter retention times, assuming it could be demonstrated that it would not jeopardize public health.

Table 6-5. Regulatory Considerations for Retention and Response Time in the RWA and TWA Portfolios

1B RWA	1C TWA	1D TWA
8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell)	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell)	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell)

6.1.6 TMF Capacity

Portfolios 1b, 1c, and 1d involve two large agencies—Valley Water and City of San José—that have an existing track-record of experience in advanced treatment and recycled water. Given this investment, it is presumed that these agencies will meet the State Board’s initial bar for TMF capacity. Nevertheless, additional efforts will likely be required (even of the experienced agencies) to demonstrate that public health can be reliably protected under the more rigorous requirements of DPR. DDW has signaled that interagency coordination will be of greater importance for DPR to ensure that all elements of the system—from source control through distribution—are optimized for public health protection. Examples of heightened coordination include the need for enhancements to source control programs and potential future requirements for the optimization of wastewater treatment plants feeding DPR AWPFs. Agreements specifying these roles and responsibilities will likely be of greater importance than in IPR settings to ensure stable partnerships.

6.1.6.1 Portfolio 1b

Of the DPR scenarios, Portfolio 1b provides the most diverse set of barriers to protect against public health threats, including source control, blending, storage, and treatment at both the AWPF and Penitencia WTP. By spreading protections across these multiple treatment and management barriers, it is less reliant on a complex, sophisticated AWPF treatment and control system to protect public health. It is therefore likely to have lower TMF requirements than the TWA scenarios. As described in previous sections, however, multiple additional efforts may be required of any DPR project to further demonstrate this capacity. As with the IPR scenarios, the lack of existing interagency agreements may present a regulatory challenge for TMF.

6.1.6.2 Portfolios 1c and 1d

The TWA portfolios rely more heavily on the AWPF than the RWA and IPR scenarios. In line with the State Water Board's guidance, the TMF requirements of the agencies pursuing TWA will likely be highest due to the number and different types of treatment processes, monitoring, and control points. As with Portfolio 1b, the TWA portfolios will likely be required to undertake additional efforts to demonstrate this capacity. The lack of existing interagency agreements also poses a challenge for TMF in these portfolios.

6.1.6.3 TMF Summary and Next Steps

Based on the scoring in Table 6-9, the DPR portfolios receive "dark blue" rankings for TMF capacity. Multiple "next steps" listed in the DPR sections above will contribute to the agencies' TMF capacity, particularly those efforts that demonstrate the agencies' ability to coordinate and address the major DPR challenges. Positive outcomes from these efforts will help demonstrate TMF capacity and may allow the projects to achieve higher rankings for this category, i.e., to move up from "dark blue" to "medium blue" rankings.

Table 6-9. Regulatory Considerations for TMF in the RWA and TWA Portfolios

1B RWA	1C TWA	1D TWA
Agencies lacking formalized interagency agreements	Agencies lacking formalized interagency agreements	Agencies lacking formalized interagency agreements

Recommended next steps for TMF capacity include:

- **DPR demonstration project and research testing**: As described previously, testing will be critical to demonstrate to the regulators, public, and other stakeholders that solutions can be implemented to address DPR challenges. Important topics to include in demonstration testing include those mentioned in this section, such as enhanced monitoring and control systems, verification of a system's ability to meet risk-based standards for pathogen control, and evidence that the treatment and management barriers can effectively address chemical peaks and unknowns. Based on the potable reuse experience in California, this type of demonstration testing is typically critical for the pioneering projects (e.g., Orange County Water District's groundwater injection project, San Diego's surface water augmentation project) in any new potable reuse paradigm. The need for demonstration testing will therefore be dependent on how quickly Valley Water and its partners intend to pursue DPR. Projects can reduce the need for such testing by waiting and relying on the experience of other agencies' projects. By leveraging others' experience, a project can reduce its investment in time and resources needed to design, test, and engage its stakeholders. Waiting for the development of regulations also provides better clarity for project planning. On the other hand, this approach requires a longer implementation timeline since it relies on the other agencies implementing projects and gaining experience for the industry at large.

Pursuing a project prior to the development of regulations also allows its sponsors to help shape and control these requirements.

- **Continue to engage partners on interagency agreements**: Based on feedback from DDW, agreements that provide definition on the roles and responsibilities of the various agencies will be even more important for TMF assessments in DPR. The existence of such agreements provide evidence of the project's ability to ensure the reliability of the potable reuse system from wastewater collection through distribution. Topics of interest for such agreements could include defining the requirements for enhanced source control programs, the quality of the secondary or tertiary effluent that is acceptable as a feed water to the AWPF, and who is responsible for upgrades and maintenance of the system.
- **Regulator and IAP engagement:** Maintaining interactions with the regulators and IAP are helpful for demonstrating TMF capacity regardless of the type of reuse, though it is particularly important for a new paradigm like DPR. Testing and research efforts should be done with the participation of DDW and the IAP to ensure that testing plans focus on the key issues of concern in their eyes and that the findings and conclusions benefit from their peer review and comments.

6.1.7 Additional Operational Modes for Greater TWA Flexibility

Valley Water is also evaluating ways to gain additional operational flexibility by blending the potable TWA sources into its Central Pipeline. In this way, TWA supplies could be distributed across the county for use at other end uses, including the LGRP and Rinconada WTP. Per discussions with DDW at the June 9, 2020 meeting, they stated that this configuration would likely not require that the downstream end uses obtain additional permits for potable reuse (e.g., GWR and RWA permits at LGRP and Rinconada WTP, respectively). Assuming that the TWA water entering the distribution system meets the requirements for potable water, it would be viewed as any other potable source and suitable for downstream applications.

Nevertheless, this configuration may require modifications to other permits to account for an additional water source that will be discharged to the environment (e.g., at the LGRP) and be used as a new source to a drinking water treatment plant. For this Master Plan, it is assumed that once potable water is introduced into the Central Pipeline it becomes raw water and would be viewed as such at Rinconada, LGRP, and environmental discharges, and would be subject to existing requirements at those points of connection or discharge. Additional conversations with DDW and the Regional Board are recommended to further pursue this option and validate this assumption.

6.1.8 West County TWA Concept

An additional TWA option that is being developed qualitatively is the West County TWA concept. Given that the same treatment train is assumed for this concept, it will likely receive similar rankings as TWA Portfolios 1c and 1d. Based on feedback from DDW at the June 9, 2020 meeting, the presence of multiple source waters should not pose additional challenges for source control and monitoring and control beyond what was described in this section. The requirements for TMF capacity for this portfolio may also be elevated due to the larger number of entities that must be coordinated through interagency agreements.

6.2 Environmental Compliance Criteria

6.2.1 RO Concentrate Management

This section will be updated when the ROC management approaches have been finalized.

6.2.2 Product Water Release

In general, TWA minimizes product water release into the environment because the AWPF effluent is introduced directly into the distribution system without passing through an environmental buffer. For most of the portfolios and TWA concepts, the AWPF product water is contained within the distribution system, and therefore environmental requirements would not apply. However, the additional operational modes being considered by Valley Water—namely, the introduction of AWPF product water (potable water) into the Central Pipeline—would result in releases into the environment. The Central Pipeline has a number of turnouts into creeks in Santa Clara County and also provides water to the LGRP. Although the AWPF product water would be considered potable water at the time it enters the distribution system, it is unclear whether the Regional Board would require additional permits to allow the product water to be released into the environment or if the combined flow would be viewed as raw water and subject to existing discharge requirements. It will be important to receive feedback from the Regional Board regarding requirements that may be associated with this operational strategy.

6.3 Summary of RWA and TWA Portfolios

A summary of the overall rankings for the DPR portfolios is presented in Table 6-10. Generally, the DPR portfolios contain more categories in the "medium blue" rankings, which is largely a reflection of the lack of regulatory certainty and existing precedents. Multiple new challenges need to be addressed and demonstrated to elevate the DPR rankings to the level of more established forms of reuse like GWR.

Table 6-10. Summary of public health regulatory considerations for the RWA and TWA portfolios

	1B RWA	1C TWA	1D TWA
Pathogens	≥15/13/13	≥15/13/13	≥15/13/13
Chemicals	High-quality WW to FAT train with enhanced robustness and multiple additional barriers	High-quality WW to FAT train with enhanced robustness and moderate additional barriers	High-quality WW to FAT train with enhanced robustness and moderate additional barriers
Source Control	Source control program likely to meet the enhanced requirements specified in future DPR regulations	Source control program likely to meet the enhanced requirements specified in future DPR regulations	Source control program likely to meet the enhanced requirements specified in future DPR regulations
Monitoring and Control	Enhanced control system with *multiple* additional barriers (treatment, blending, retention)	Enhanced control system with *moderate* number of additional barriers	Enhanced control system with *multiple* additional barriers (treatment, blending, retention)
Retention and Response Time	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell)	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell)	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell)
TMF	Agencies lacking formalized interagency agreements	Agencies lacking formalized interagency agreements	Agencies lacking formalized interagency agreements

Of the DPR portfolios, RWA has the highest ranking, which reflects a number of considerations, including:

- The State Board views RWA as having a lower risk profile than TWA.
- The portfolio incorporates a broad range of treatment and management barriers that spread the burden of public health protection across a wider range of elements.
- The RWA train provides the highest degree of treatment redundancy.

The TWA portfolios have more topics that fall into the "medium blue" category given the lower degree of redundancy and the subsequent increased reliance on treatment, monitoring, and controls.

As noted throughout the TM, there are multiple requirements that remain undetermined; assumptions have been made regarding topics such as minimum levels of pathogen redundancy, suitability of O_3/BAC for the control of unknown chemicals and chemical peaks, and the role of the surface water treatment plant in

RWA. In the June 9, 2020 meeting, DDW provided additional insight into the feasibility of the portfolios, and this feedback was included in this evaluation. Of note, DDW provided additional clarity on the role of the surface water treatment plant, the importance of interagency agreements, and confirmation of the technical challenges related to topics such as monitoring and control.

Interactions with the regulators and IAP should be used to solicit feedback on the feasibility of the DPR (and other IPR) portfolios. Based on feedback from DDW, there were no components of the portfolios that were immediate “no-go” items that impacted feasibility. One key topic to discuss further with the IAP is surface water treatment plant crediting:

- Under what conditions would Penitencia WTP be able to maintain the default 4/3/2 credits under the Surface Water Treatment Rules?
- What level of blending would be required to gain these credits?
- Are site-specific studies going to be necessary for WTP credit in all RWA scenarios?

Feedback on these and other topics will be important to solicit from DDW and IAP. Understanding their concerns will be critical for modifying the portfolios and/or addressing these issues through future efforts.

These interactions should also seek to identify what work would be most productive in supporting the pursuit of the DPR portfolios. Demonstration testing will likely be a requirement for the initial projects pursuing DPR. Test plans should be developed in conjunction with both DDW and the IAP and could be used to address a multitude of issues, including:

- Demonstrating the effectiveness of a DPR-caliber monitoring and control system.
- Evaluating pathogen removal performance of the WWTP to gain additional LRV credits.
- Testing alternative forms of surrogate monitoring to enhance LRV credit through RO.

This information would be valuable to help Valley Water plan for future efforts to further advance preferred options for potable reuse. Continued interaction with both the State Water Board, Regional Water Board, and IAP are encouraged.

Section 7: NPR Portfolios

All of the participating wastewater agencies already produce disinfected tertiary recycled water and do not have plans to produce other types of non-potable recycled water at this time. Therefore, only the requirements for disinfected tertiary recycled water are included in the summary provided in Table 7-1. The requirements are organized into categories for the protection of public health and the environment, as all non-potable end-uses for the recycled water impact both of these categories.

Table 7-1. Summary of Regulatory Requirements for Disinfected Tertiary Recycled Water	
Non-potable Reuse Requirements for Disinfected Tertiary Recycled Water	
Public Health Criteria	
Treatment Criteria	Oxidation and tertiary filtration complying with the following criteria: • Coagulant addition upstream of filtration, as needed • Filter loading rate ≤ 5 gpm/sf • Filter effluent turbidity ≤ 2 NTU on a 24-hour average, ≤ 5 NTU more than 5% of the time, and ≤ 10 NTU at any time Disinfection via: • Chlorine providing 450 mg-min/L CT and at least a 90-minute modal contact time, OR a process that has been demonstrated to achieve 5-log virus reduction using the indicators F-specific bacteriophage MS2 or polio virus • Total coliform bacteria from final effluent samples must not exceed a 7-day median concentration of 2.2 MPN/100 mL, 23 MPN/100 mL more than once in any 30-day period, and 240 MPDN/100 mL at any time
Source Control	Must meet general industrial pretreatment and pollutant source control program requirements
Monitoring and Control	The following monitoring and control strategies are required: • Flow rate measurement of filter effluent • Turbidity measurement of filter influent and effluent • Chlorine and flow rate measurement to monitor chlorine disinfection • Daily (5 days per week) lab analysis of coliform samples • Collection of online records from monitoring equipment for compliance • DDW approval of a Title 22 Engineering Report detailing design criteria and monitoring and reporting strategies.
Environmental Criteria	
Order 2016-0068-DDW, Water Reclamation Requirements	The recycled water produced for non-potable uses shall: • Not degrade groundwater and/or surface water • Not create nuisance conditions
California Water Code Sections 1210-1212, Wastewater Effluent Water Rights	A wastewater change petition must be filed with the Division of Water Rights if the recycled water project will decrease the amount of water in a waterway. This petition is submitted by the owner of the impacted wastewater treatment plant.
SF Bay Basin Plan	The recycled water must comply with the requirements included in the SF Bay Basin Plan. Compliance with the applicable water quality objectives (depending on the location of the project in Santa Clara County) must be demonstrated through the application process for producing non-potable recycled water.
Santa Clara Subbasin SNMP	Numeric groundwater quality objectives that align with the SF Bay Basin Plan for TDS, nitrate (as NO_3), and nitrate plus nitrite (as N)

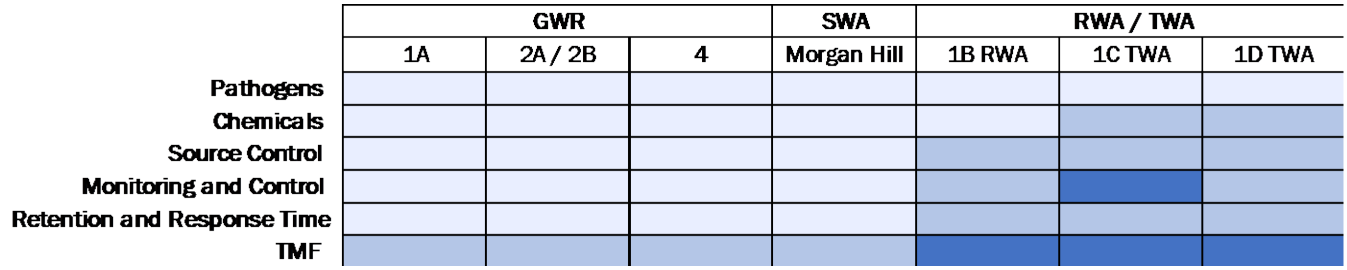
The Master Plan does include options to expand the regional reliability of the recycled water systems through the linking of systems via interties. Assuming that the individual recycled water producers continue to meet the regulatory requirements for both their tertiary disinfected and environmental discharges, there should not be additional regulatory requirements for the systems. One issue that may need to be addressed relates to defining roles and responsibilities in an intertied system. To ensure compliance with all applicable regulations, coordination among the participating agencies will be critical, as the water being distributed to customers throughout Santa Clara County may come from a number of sources. This topic should be raised at a future meeting with both the State and Regional Boards.

Section 8: Summary and Next Steps

8.1 Summary

The Master Plan contains seven potable reuse portfolios—including GWR, SWA, RWA, and TWA—that have been evaluated in this TM. The regulations for the existing forms of reuse—GWR and SWA—were used to develop a set of six criteria for evaluating the IPR portfolios. Ranks were assigned to each of the criteria based on a number of factors, including both regulatory certainty, number of precedents, and the experience of other permitted projects. The same six criteria were used to evaluate the DPR portfolios as well, though assumptions needed to be made in the development of rankings due to the fact that the State Board has not yet developed DPR regulations. In general, the regulatory clarity and larger number of precedents provided a clearer regulatory compliance pathway for GWR portfolios—the reuse type with the longest history in California. The uncertainty and lack of precedents made it more difficult to achieve the same clear pathway for DPR. A summary of the rankings for the seven portfolios is shown in Table 8-1.

Table 8-1. Summary of Regulatory Considerations for Public Health in the Potable Reuse Portfolios



	GWR			SWA	RWA / TWA		
	1A	2A / 2B	4	Morgan Hill	1B RWA	1C TWA	1D TWA
Pathogens	░	░	░	░	░	░	░
Chemicals	░	░	░	░	░	▒	▒
Source Control	░	░	░	░	▒	▒	▒
Monitoring and Control	░	░	░	░	▒	█	▒
Retention and Response Time	░	░	░	░	▒	▒	▒
TMF	▒	▒	▒	▒	█	█	█

Generally, the scoring shows a range of regulatory compliance complexity that moves from more straightforward compliance with the GWR portfolios to increasing complexity moving to SWA, RWA, and then TWA. As discussed throughout the document, many of the “medium blue” and “dark blue” rankings are not fixed, but are initial starting points based on the lack of clarity on specific topics. Future efforts could be used to make the regulators more comfortable with these topics (and therefore lead to an upgrade in scoring). Such efforts include additional demonstration testing, for example, that might be used to establish the public health protectiveness of a candidate treatment train or to demonstrate the proper functioning of an enhanced monitoring and control system. This and other next steps are presented in the following section.

The portfolios must also demonstrate compliance with environmental discharge considerations. Generally, each portfolio must present a plan to address compliance with ROC and—in all but the DPR portfolios—purified water released to the environment. A summary of the regulatory considerations for environmental compliance rankings in the seven portfolios is shown in Table 8-2. Note that if the TWA scenarios included the release of AWPF product water into the Central Pipeline, compliance with environmental regulations may be required. As noted in Section 6, communication with the Regional Board regarding the regulatory requirements that maybe applicable to this scenario is recommended.

Table 8-2. Summary of Regulatory Considerations for Environmental Compliance in the Potable Reuse Portfolios

	GWR				SWA	RWA / TWA
	1A	2A	2B	4	Morgan Hill	1B/1C/1D
	Product Water Release					
SF Basin Plan						N/A
California Toxics Rule						N/A
SNMP					N/A	N/A
Anti-Degradation						N/A
Chlorine Residual						N/A

8.2 Next Steps

This regulatory compliance TM represents an initial evaluation of issues that may impact the feasibility of the potable reuse portfolios in the Master Plan. The rankings provided here could move based on a number of factors, including engagement and feedback from regulators on the portfolios, greater clarity on the future regulatory requirements for DPR, and additional efforts by Valley Water and its partners to address or resolve the issues marked in “medium blue” and “dark blue.” A number of immediate next steps have been identified in the potable reuse sections, including:

- Demonstration testing of the potable reuse treatment systems
- Evaluation of enhanced monitoring and control systems
- Continued engagement with partners on interagency agreements
- Pathogen monitoring campaigns to support higher WWTP LRV credits
- Studies to evaluate the amount of blending available in the SWA, RWA, and TWA portfolios
- Evaluation of surface water treatment plant performance and crediting in RWA scenarios
- Communication with the Regional Board regarding the feasibility of ROC management strategies
- Communication with the Regional Board regarding AWPF product water release to confirm permitting requirements for all portfolios

Additional studies and next steps should be discussed with both the regulators and the IAP during their review of the Master Plan portfolios. Once greater clarity is obtained on which portfolio(s) will be carried into future phases, additional studies will need to be completed to further support those pursuits. These include reuse-specific studies such as:

- Hydrodynamic studies to confirm mixing and dilution requirements in SWA reservoirs
- Tracer studies to validate hydrodynamic models (SWA)
- Tracer studies to confirm aquifer retention time (GWR)
- Preliminary studies related to ROC discharge and AWPF product water release for all portfolios to confirm feasibility of compliance with applicable environmental requirements

Multiple years may be required to undertake the complete process of implementing a potable reuse project. Various steps are typically involved, starting with the development and testing of a potable reuse concept before moving into the design, permitting, construction, and start-up of the system. Two recently permitted projects—Monterey One Water’s GWR project and the City of San Diego’s SWA project—were both pursued with expedited timelines and required more than 10 years for completion. Example timelines are presented for Monterey (Figure 8-1) and San Diego (Figure 8-2).

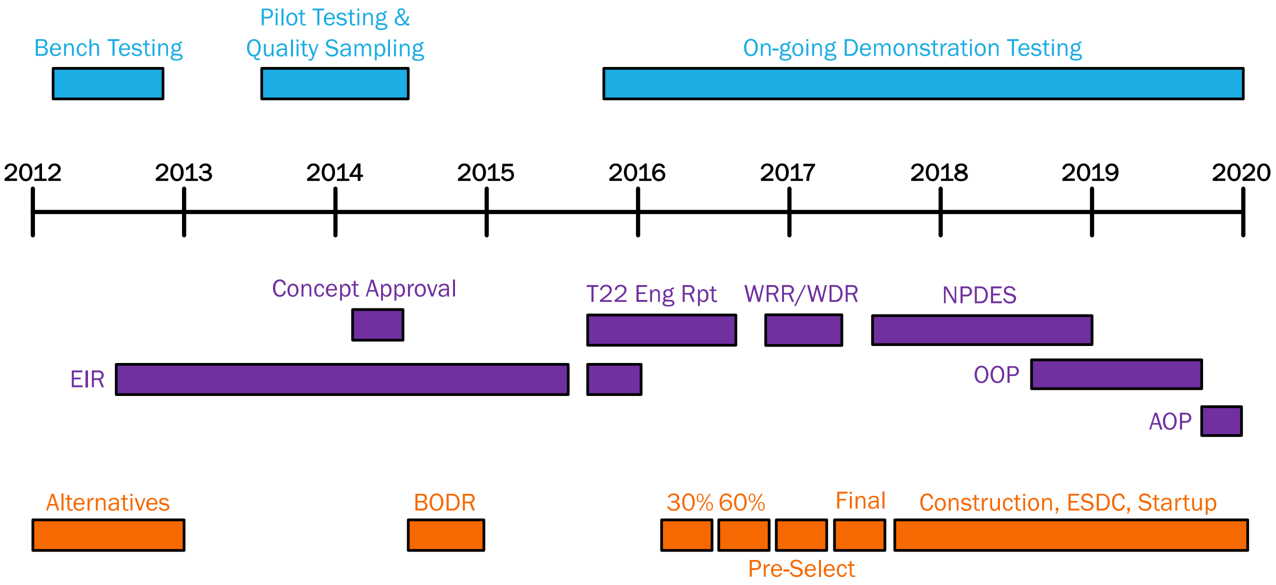


Figure 8-1. Project timeline for Monterey One Water's Pure Water Monterey groundwater recharge project. The colors denote research and testing efforts (blue), permitting efforts (purple), and design and construction (orange)

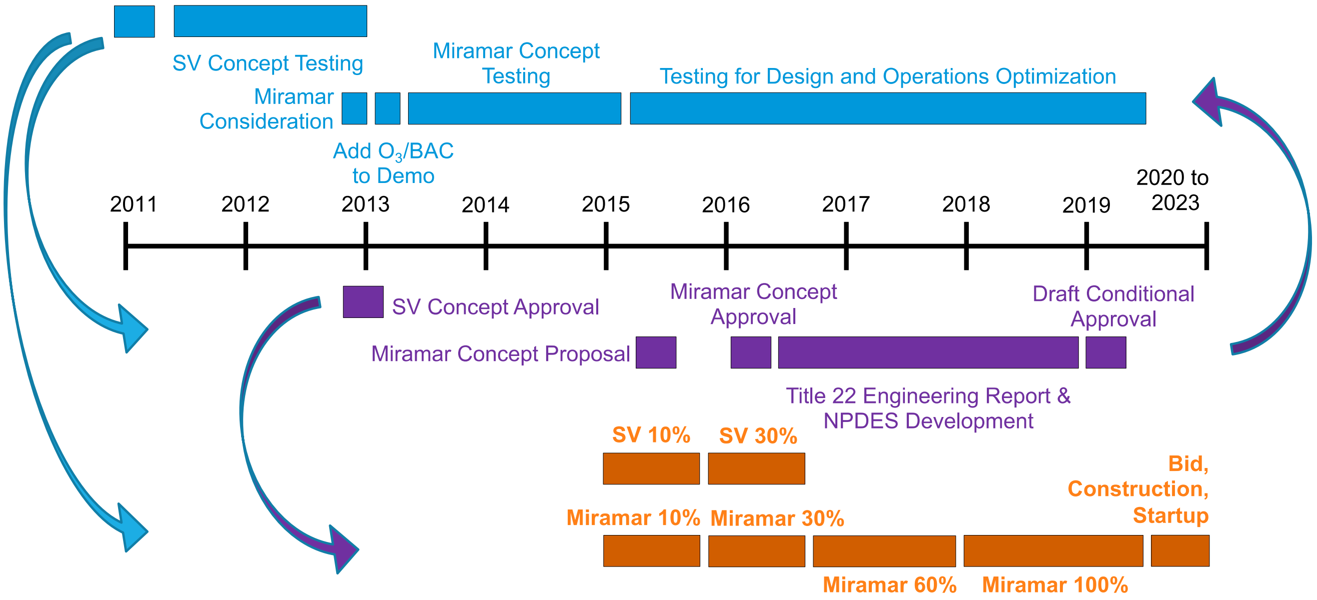


Figure 8-2. Project timeline for the City of San Diego's North City Pure Water project for surface water augmentation. Colors denote research and testing efforts (blue), permitting efforts (purple), and design and construction (orange)

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Appendix B-2: Regulatory Framework TM

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Technical Memorandum

Prepared for:	Santa Clara Valley Water District (Valley Water)
Project title:	Countywide Water Reuse Master Plan
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Appendix B2

Subject:	Regulatory Framework
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Limitations:

This document was prepared solely for Valley Water in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for the partners, regulatory agencies, and stakeholders contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

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List of Abbreviations

°C	Celsius
°F	Fahrenheit
µg/L	micrograms per liter
AB	Assembly Bill
AFY	acre-foot/feet per year
AGR	agricultural supply
AOP	advanced oxidation process
AWTF	advanced water treatment facility
BA	Biological Assessment
BAC	biological activated carbon
Basin Plan	Water Quality Control Plan for the San Francisco Bay Basin
BOD_5	biochemical oxygen demand
$CBOD_5$	5-day carbonaceous biochemical oxygen demand
CC	Central Coast
CCC	criterion continuous concentration
CCR	California Code of Regulations
CDPH	California Department of Public Health
CECs	contaminants of emerging concern
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CMC	criterion maximum concentration
COLD	cold freshwater habitat
COMM	commercial and sport fishing
CTR	California Toxics Rule
CWC	California Water Code
CWEA	California Water Environment Association
DBPs	disinfection by-products
DDW	Division of Drinking Water
District	Santa Clara Valley Water District
DPR	direct potable reuse
DS2.2	Disinfected secondary-2.2 recycled water
DS23	Disinfected secondary-23 recycled water
DT	Disinfected tertiary recycled water
DWTF	drinking water treatment facility
EA	Environmental Assessment
EIR	environmental impact report
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EST	estuarine habitat
FAT	full advanced treatment
FRSH	freshwater replenishment
GRRP	groundwater replenishment reuse project
GWR	groundwater recharge
H_2O_2	hydrogen peroxide
HOCl	hypochlorous acid
IAP	Independent Advisory Panel
IND	industrial service water supplies
IPR	indirect potable reuse
L	liter(s)
LASAN	Los Angeles Bureau of Sanitation
LACSD	Los Angeles County Sanitation District
LRV	log removal value
Master Plan	Countywide Water Reuse Master Plan
MCL	maximum contaminant level
MF	microfiltration
mg	milligram(s)
mg/L	milligrams per liter
mgd	million gallons per day
mg-min	milligram-minutes
MIGR	Fish migration
mL	milliliters
MPN	most probable number
MRP	Monitoring and Reporting Program
MUN	municipal and domestic supply
N	nitrogen
NAV	Navigation
NEPA	National Environmental Policy Act
NL	notifications level
NO_3	nitrate
NOA	Notice of Applicability
NOI	Notice of Intent

NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NWRI	National Water Research Institute
O&M	operations and maintenance
OCWD	Orange County Water District
Padre Dam	Padre Dam Municipal Water District
PCB	polychlorinated biphenyl
Plan	Operations and Management Plan
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
PR	potable reuse
PROC	process water supply
Q	flow
QMRA	quantitative microbiological risk assessment
RARE	Preservation of rare and endangered species
REC-1	Water contact recreation
REC-2	Non-contact water recreation
Regional Board	Regional Water Quality Control Board
RO	reverse osmosis
RWA	raw water augmentation
RWC	recycled water contribution
RWF	regional wastewater facility
RWQCP	Regional Water Quality Control Plant
SAP	Science Advisory Panel
SAT	soil aquifer treatment
SB	California Senate Bill
SBSPRP	South Bay Salt Pond Restoration Project
SCRWA	South County Regional Wastewater Authority
SF	San Francisco
SFB	San Francisco Bay
SFPUC	San Francisco Public Utilities Commission
SHELL	Shellfish harvesting
SIP	State Implementation Policy
SMCL	secondary maximum contaminant level
SNMP	Salt and Nutrient Management Plan
SPWN	Fish spawning
SRF	State Revolving Fund
State Board	State Water Resources Control Board
SWA	surface water augmentation
t	retention time
TDS	total dissolved solids
Thermal Plan	Control of Temperature in Coastal and Interstate Waters and Enclosed Bays and Estuaries of California
TMDL	Total Maximum Daily Load
TMF	technical, managerial, and financial
TOC	total organic carbon
TSS	total suspended solids
TWA	treated water augmentation
UDS	Undisinfected secondary recycled water
USFWS	U.S. Fish and Wildlife Service
UV	ultraviolet
V	volume
V/G/C	virus, *Giardia, Cryptosporidium*
WARM	Warm freshwater habitat
WDR	waste discharge requirement
WILD	wildlife habitat
WPCP	Donald M. Somers Water Pollution Control Plant
WRR	water reclamation requirement
WWTP	wastewater treatment plant

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Section 1: Overview of Water Reuse Policy in California

This section of the technical memorandum presents a brief history and overview of water reuse policy in California, including relevant regulations, regulatory agencies' responsibilities, recycled water in Santa Clara County, and recycled water regulatory structure.

1.1 History and Relevant Regulations

For more than a century, California has been effectively using recycled water as a non-potable water supply. As freshwater demand exceeds supply, recycled water is a highly attractive water supply option. For several decades, recycled water has been used for agricultural and landscape irrigation, groundwater recharge (GWR) (indirect potable reuse [IPR]), environmental and recreation enhancement, industrial applications and cooling, and to prevent seawater intrusion. Planned IPR by GWR of potable aquifers has been practiced in the state as early as 1953. California has been, and continues to be, a leader in water reuse.

California law has provided that the State's interest in conservation of water resources requires the maximum reuse of treated wastewater (Water Reuse Law, Water Code Sections 461–465). The California Water Code (CWC) is the principal State regulation governing the use of water resources within the state of California. This law controls and impacts water rights, development, and use of state water resources; water quality protection and management; management of water-oriented agencies; and applicable water reclamation requirements (WRR). The Porter-Cologne Water Quality Control Act (Porter-Cologne Act), which was the precursor to the federal Clean Water Act of 1972, is a prominent part of the CWC and serves as the State's comprehensive program for the protection of water quality and the beneficial uses of water.

The CWC provides that the State should encourage Californians to develop water recycling to meet the State's water needs and augment surface water and groundwater supplies (Water Reclamation Law, CWC Sections 13500–13556). California has steadily increased its use of recycled water since 1991, when the California Water Reclamation Act (CWC Section 13577) set water recycling goals. Revised recycled water targets were adopted in 2009 with the implementation of the State Water Resources Control Board's (State Board) Recycled Water Policy, which set a goal to increase the annual use of recycled water over 2002 levels by at least 1 million acre-feet by 2020 and at least 2 million acre-feet by 2030. The California Legislature continues to make progress in overcoming the institutional obstacles to water recycling, with the State Board developing standards for potable reuse (PR) for GWR and surface water augmentation (SWA), and a goal of establishing uniform criteria for direct potable reuse (DPR) by 2023. In addition, periodic drought has spurred increased attention to recycled water as a readily available resource, and public acceptance for its use continues to grow.

1.2 Regulatory Agencies' Responsibilities

The regulatory agencies with primary responsibility for regulating recycled water in California are the State Board and the nine Regional Water Quality Control Boards (Regional Board), which were created by the Porter-Cologne Act.

1.2.1 State Water Resources Control Board

The State Board is responsible for setting statewide water quality policy and WRRs. The State Board's Division of Drinking Water (DDW, formerly California Department of Public Health [CDPH]) has statutory authority in two areas with respect to recycled water reuse. It regulates public water systems in accordance with the California Safe Drinking Water Act (Health and Safety Code Section 116270 et seq.), and develops and adopts water recycling criteria as required by Section 13521 of the CWC. DDW does not have enforcement authority for water recycling criteria; they are enforced through permit systems administered by the nine Regional Boards under the overall authority of the State Board.

1.2.2 Regional Water Quality Control Boards

The nine Regional Boards implement water quality planning and regulatory decisions for their specific regions. The Regional Boards issue waste discharge requirements (WDR) (i.e., discharge permits) and administer National Pollutant Discharge Elimination System (NPDES) permits. The Regional Boards regulate discharges under the Porter-Cologne Act primarily through the issuance of WDRs, with the CWC providing enforcement through cease and desist orders, cleanup and abatement orders, administrative civil liability orders, civil court actions, and criminal prosecution. Specific regulatory responsibilities affecting water reuse include:

- Approving pollutant source control programs for wastewater systems
- Issuing and enforcing WRRs to producers and users of recycled water
- Defining beneficial uses of surface water and groundwater bodies by establishing water quality control plans
- Regulating operators of water reclamation treatment plants
- Making water rights determinations regarding water reclamation

All persons who recycle or propose to recycle water, and who use or propose to use recycled water, must file a report with the appropriate Regional Board (CWC Section 13522.5). If a Regional Board determines that it is necessary to protect public health, safety, or welfare, it may prescribe WRRs where recycled water is used or proposed to be used (CWC Section 13523). The Regional Board must consult with and consider recommendations of DDW when issuing WDRs/WRRs (CWC Section 13523).

1.3 Recycled Water in Santa Clara County

Water reuse is an expanding source of water for Santa Clara County. Water reuse augments drinking water and groundwater supplies through in-lieu recharge; provides a reliable, drought-resistant, locally controlled water supply; and reduces reliance on imported water. In 2016, recycled water accounted for approximately 5 percent (about 20,000 acre-feet per year [AFY]) of the county's total water supply, being distributed for non-potable water uses such as landscape and agricultural irrigation, industrial cooling, and dual-plumbed facilities. Recycled water is produced at the four wastewater treatment plants (WWTP) in the county:

- Palo Alto Regional Water Quality Control Plant (RWQCP)
- San José/Santa Clara Regional Wastewater Facility (RWF)
- South County Regional Wastewater Authority (SCRWA) WWTP
- Sunnyvale's Donald M. Somers Water Pollution Control Plant (WPCP)

In 2015, the Santa Clara Valley Water District (Valley Water) began a water supply planning process to develop at least 24,000 AFY, and up to 45,000 AFY, of PR capacity. Subsequently, the *Countywide Water Reuse Master Plan* (Master Plan) will outline Valley Water's approach to achieving its target that recycled water, including both non-potable reuse (NPR) and PR, constitute
10 percent of the county's water supply by 2025.

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1.4 Recycled Water Regulatory Structure

The goal of this document is to describe the key regulations applicable to both NPR and PR. In general, the regulations fall under two categories: (1) public health protection criteria, and (2) environmental discharge criteria. Public health protection criteria generally include requirements for treatment, monitoring, and effluent water quality for the designated end use (e.g., landscape irrigation and groundwater recharge). Environmental discharge criteria consist of water quality requirements to protect surface water and groundwater quality for all designated beneficial uses. The sources of the criteria in Santa Clara County, as well as requirements for project implementation for the different types of reuse, are summarized in Table 1-1.

Table 1-1. Summary of Regulatory Criteria and Requirements for Water Reuse Applications in Santa Clara County

	Public Health Criteria	Environmental Discharge Criteria
Non-Potable Reuse		
Regulations	Recycled Water Policy [a] CCR Title 22, Division 4, Chapter 3	SFB and CC Basin Plans Salt and Nutrient Management Plans
Requirements	Approved Title 22 Engineering Report (State Board) Site-specific Water Recycling Requirements/Waste Discharge Requirements *or* Order 2016-0068-DDW Water Reclamation Requirements (Regional Board) Order R2-1996-0011	
Groundwater Recharge		
Regulations	Recycled Water Policy CCR Title 22, Division 4, Chapter 3	SFB and CC Basin Plans Salt and Nutrient Management Plans
Requirements	Approved Title 22 Engineering Report (State Board) Water Recycling Requirements (Regional Board) Waste Discharge Requirements (Regional Board)	
Surface Water Augmentation		
Regulations	CCR Title 22, Division 4, Chapter 3 CCR Title 22, Division 4, Chapter 17	SFB and CC Basin Plans California Toxics Rule Thermal Plan Order 2014-0194-DWQ CA Antidegradation Policy
Requirements	Approved Title 22 Engineering Report (State Board) Water Recycling Requirements (Regional Board) NPDES Permit containing Waste Discharge Requirements (Regional Board)	

a. *State Water Board Resolution 2009-0011.*

Public health protection criteria are developed by the State Board and contained in the California Code of Regulations (CCR) Title 22 Uniform Water Recycling Criteria (CDPH 2014). Specific criteria for each form of reuse are discussed in detail in the following sections. In general, these criteria are enforced through the use of WDRs, WRRs, or other appropriate permits issued by the Regional Board. These permits specify requirements for treatment, monitoring, reporting, effluent water quality, and any other elements of the water recycling criteria that are relevant for a given application. The Regional Boards generally ensure that reuse projects can meet the recycling criteria by requiring projects to receive State Board approval of a Title 22 Engineering Report to obtain a discharge permit.

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Environmental discharge criteria can vary substantially depending on the specific discharge location and the type of reuse. In the northern portion of Santa Clara County, discharges are subject to the provisions of the Water Quality Control Plan for the San Francisco Bay Basin (SFB Basin Plan, while the Water Quality Control Plan for the Central Coast Basin (CC Basin Plan) covers discharges in the Llagas Subbasin south of Coyote Valley (Regional Board 2015). These and other relevant provisions are discussed in detail in the subsequent sections. In all cases, the criteria are based on protecting receiving waters (e.g., aquifers and reservoirs) to ensure that water quality is maintained for all beneficial uses. Environmental discharge criteria are enforced through a permit, and the type of permit depends on the receiving water. Discharges to aquifers, which are not considered waters of the United States, are governed by WDRs issued by the Regional Board. Discharges to reservoirs, on the other hand, require a permit under the NPDES program, which would also be issued by the Regional Board, along with WDRs specific to any state water quality policies and regulations.

The following sections provide detailed discussion of the public health and environmental discharge criteria for NPR, GWR, and SWA. Uniform water recycling criteria do not currently exist for DPR but are under development by DDW; the discussion of DPR focuses on public health protection elements that are likely to be included in the criteria.

Section 2: Non-potable Reuse

This section describes NPR, including approaches, a regulatory summary, and regulatory requirements.

2.1 Approaches

NPR is the beneficial reuse of recycled water in non-potable situations, such as irrigation for landscaping. Typically, recycled water is treated at a WWTP and sold to recycled water users through a separate distribution system, usually colored purple to distinguish it from the potable water distribution system.

The water quality requirements for the following four types of recycled water, listed in order of increasing water quality, are defined in the Uniform Statewide Recycling Criteria:

- Undisinfected secondary recycled water (UDS) (CCR, Title 22, Section 60301.900)
- Disinfected secondary-23 recycled water (DS23) (CCR, Title 22, Section 60301.225)
- Disinfected secondary-2.2 recycled water (DS2.2) (CCR, Title 22, Section 60301.220)
- Disinfected tertiary recycled water (DT) (CCR, Title 22, Section 60301.230)

Each category of recycled water has unique water quality requirements, which are discussed further in Section 2.3. The allowable end uses for non-potable recycled water are dictated by water quality, and range from strictly irrigation of landscaping to use in decorative fountains. A summary of typical end uses is presented in Table 2-1. Any use of recycled water that is not addressed in the Title 22 regulations is considered on a case-by-case basis by the Regional Boards (State Board 2016).

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Table 2-1. Typical End Uses for Recycled Water

Category of Recycled Water	Typical End Uses
UDS	• Irrigation of non-food-bearing trees, seed crops not being consumed by humans, food and pasture for animals not producing milk for human consumption, and flushing of sanitary sewers
DS23	• All end uses of UDS • Irrigation of landscaping, including freeways, golf courses, and sod farms; use in industrial or commercial cooling that does not create a mist; industrial boilers; nonstructural firefighting; and cleaning of streets and outdoor work areas
DS2.2	• All end uses of UDS and DS23 • Irrigation of food crops, orchards, and vineyards not contacted by the recycled water; and use in fish hatcheries
DT	• All end uses of UDS, DS23, and DS2.2 • Irrigation of food crops where recycled water contacts the edible portion of the crop, parks, playgrounds, school yards, and residential landscaping; use in industrial or commercial cooling that does create a mist, flushing toilets, and decorative fountains

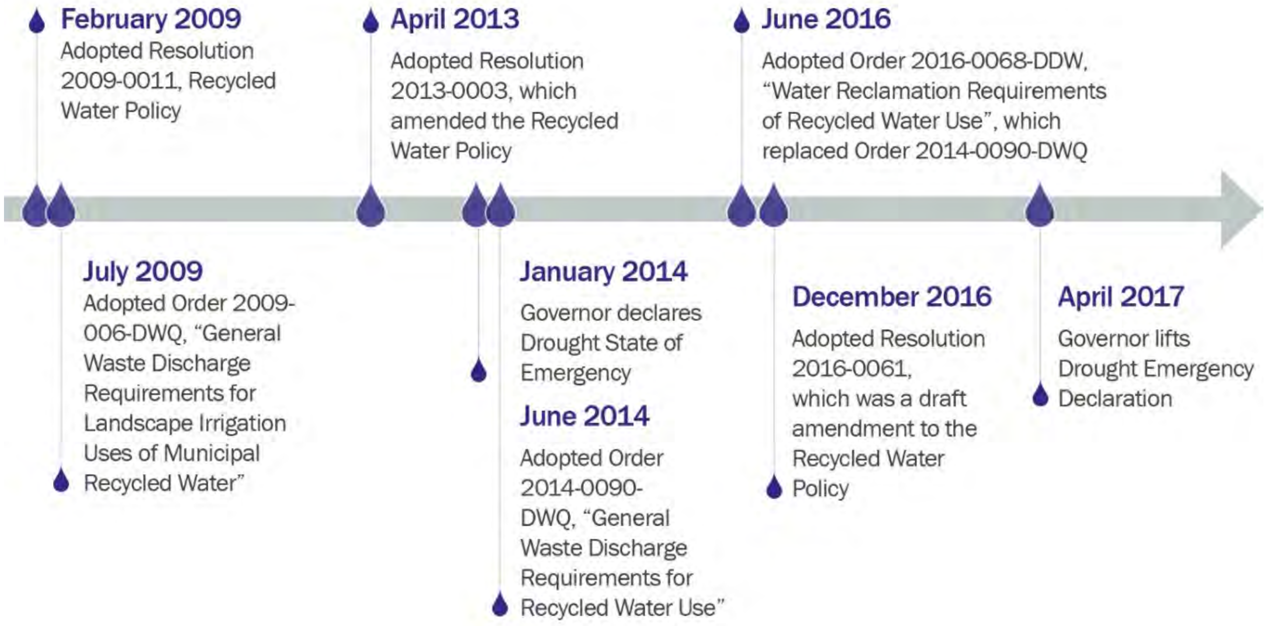
Source: Title 22 Water Recycling Criteria, adopted 7/16/2015.

Note: This is not intended to be a full list of allowable end uses of recycled water. Refer to the Title 22 regulations for the comprehensive list of end uses.

The four WWTPs within the scope of this study, which include the San José/Santa Clara RWF, Sunnyvale WPCP, Palo Alto RWQCP, and SCRWA WWTP, all currently produce disinfected tertiary recycled water for non-potable uses.

2.2 Regulatory Summary

Recycled water for NPR is carefully regulated, but is considered a traditional application of recycled water and has a relatively straightforward permitting process. The major recycled water regulations applicable to NPR are shown in Figure 2-1 and described below.



February 2009
Adopted Resolution 2009-0011, Recycled Water Policy

July 2009
Adopted Order 2009-006-DWQ, "General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water"

April 2013
Adopted Resolution 2013-0003, which amended the Recycled Water Policy

January 2014
Governor declares Drought State of Emergency

June 2014
Adopted Order 2014-0090-DWQ, "General Waste Discharge Requirements for Recycled Water Use"

June 2016
Adopted Order 2016-0068-DDW, "Water Reclamation Requirements of Recycled Water Use", which replaced Order 2014-0090-DWQ

December 2016
Adopted Resolution 2016-0061, which was a draft amendment to the Recycled Water Policy

April 2017
Governor lifts Drought Emergency Declaration

Figure 2-1. California recycled water regulations have been streamlined to support the development of NPR projects

California Title 22 Regulations. California regulates the treatment, use, and discharge of recycled water according to Title 22 of the CCR. Title 22 covers environmental health, which includes water-related issues. Chapter 3 within Title 22 covers all recycled water quality standards and appropriate end uses, which are described below in Sections 2.2 and 2.3.

Recycled Water Policy (created in 2009 and amended in 2013 and 2018). The State Board first developed the Recycled Water Policy to expedite implementation of projects using municipal recycled water for landscape irrigation and meeting regulatory requirements for treatment level and use area restrictions as prescribed by Title 22 in 2009. It was amended in 2013 to add contaminants of emerging concern (CEC) monitoring requirements for potable reuse projects, which came from a Science Advisory Panel (SAP) on CECs. The Recycled Water Policy streamlines the permitting process for landscape irrigation recycled water projects through a general permit. Salt and nutrient management planning is also a key requirement to assist in streamlined permitting.

In April 2018, a new report of the SAP was released, "Monitoring Strategies for Constituents of Emerging Concern in Recycled Water." The Recycled Water Policy incorporates the SAP recommendations for potable reuse projects, notably two new bioassay monitoring requirements. An amendment adopted in December 2018 (and made effective on April 8, 2019) incorporates regulatory developments that have taken place since the policy was last amended in 2013, as well as recommendations of the SAP.

General Orders for Non-Potable Reuse of Municipal Recycled Water. General Orders are used by the State and Regional Boards to streamline permitting for reuse projects. Permitting under a General Order requires that projects comply with all relevant requirements of Title 22. Additional requirements are specific within each General Order.

- **Order 96-011. "General Reuse Requirements for Municipal Wastewater and Water Agencies" (1996).** This Order was issued by the California Regional Water Quality Control Board, SFB Region. This General Water Reuse Order authorized municipal wastewater reuse of NPR throughout the region. It streamlined the permitting process (replacing individual reuse orders) and delegated the responsibility of administrating water reuse programs to local agencies. A separate NPDES permit is required to use ephemeral or year-round streams or other waters of the State for recycled water conveyance or direct or indirect groundwater recharge,
- **Order 2009-0006-DWQ "General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water" (July 2009).** This General Order updated the regulatory process for landscape irrigation uses of recycled water. Most recycled water irrigation of landscaping at parks, greenbelts, playgrounds, school yards, athletic fields, golf courses, cemeteries, residential common areas, commercial and industrial areas, and along freeways, highways, and streets are eligible for coverage.
- **Order 2014-0090-DWQ "General Waste Discharge Requirements for Recycled Water Use" (June 2014).** This General Order was adopted in response to a Drought State of Emergency proclaimed on January 17, 2014, by California's governor. This General Order established standard conditions for recycled water use and conditionally delegated authority to an administrator to manage a Water Recycling Program and issue Water Recycling Permits to recycled water users. Only treated municipal wastewater for non-potable uses can be permitted, including landscape irrigation, crop irrigation, dust control, industrial/commercial cooling, and decorative fountains. This General Order also mandates the submission of a Title 22 Engineering Report as well as technical reports for the Notice of Intent (NOI) and Monitoring and Reporting Program (MRP) (Section 2.3) to ensure compliance and satisfy Water Code 13267 requirements.

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- **Order 2016-0068-DDW "Water Reclamation Requirements for Recycled Water Use" (June 2016).** The State Board adopted Order 2016-0068-DDW to replace the existing statewide Waste Discharge Requirements for Recycled Water Use (2014-0090-DWQ). This General Order is intended to further encourage recycled water projects by (1) acknowledging recycled water as a resource and (2) allowing recycled water programs that are implemented in multiple Regional Board boundaries to be permitted by the State Board.

2.3 Regulatory Requirements

This section describes the regulatory requirements for the non-potable use of recycled water, including pertinent public health criteria, environmental criteria, and permitting criteria and requirements.

2.3.1 Public Heath Criteria

To maintain public health protection, the categories of recycled water have increasingly stringent water quality requirements as the potential for public exposure increases. These water quality criteria are described in Table 2-2.

Table 2-2. Water Quality Criteria for NPR

Category of Recycled Water	Definition and Water Quality Criteria
UDS	Wastewater in which the organic matter has been stabilized, is non-putrescible, and contains dissolved oxygen (CCR, Title 22, §60301.900 and 650)
DS23	Recycled water that has been oxidized and disinfected so that: • Median concentration of total coliform bacteria no greater than a most probable number (MPN) of 23 per 100 milliliters (mL) and total coliform bacteria no more than an MPN of 240 per 100 mL (CCR, Title 22, §60301.225)
DS2.2	Recycled water that has been oxidized and disinfected so that: • Median concentration of total coliform bacteria is no greater than an MPN of 2.2 per 100 mL and the number of total coliform bacteria is no more than an MPN of 23 per 100 mL (CCR, Title 22, §60301.220)

DT	A filtered and disinfected water that meets the following criteria:
	• Filtered wastewater has been disinfected by either of the following:
	  • A chlorine disinfection process that provides a CT (concentration x contact time) value of no less than 450 milligram-minutes (mg-min) per liter (L) always with a modal contact time of no less than 90 minutes
	  • A disinfection process that is demonstrated to inactivate and/or remove 99.999% of the plaque-forming units of F-specific bacteriophage MS2 or polio virus
	• And median concentration of total coliform bacteria no more than an MPN of 2.2 per 100 mL and the number of total coliform bacteria does not exceed an MPN of 23 per 100 mL in more than one sample in a 30-day period and no sample shall exceed an MPN of 240 total coliform bacteria per 100 mL (CCR, Title 22, §60301.230)

Source: Title 22 Water Recycling Criteria, adopted 7/16/2015.

Note: This is a summarized version of the water quality criteria for recycled water. Refer to the referenced sections with Title 22 for the full water quality criteria.

2.3.2 Environmental Criteria

While recycled water is not discharged directly into groundwater or surface water, it is important to consider the potential impact on groundwater through percolation and surface water through runoff. Environmental criteria for recycled water are governed by General Order WQ 2016-0068-DDW here under the SFB Regional Board, the *San Francisco Bay Basin Plan,* and the CC Regional Board, *Central Coastal Basin Plan*. They are also governed by pertinent Salt and Nutrient Management Plan (SNMP) requirements.

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2.3.2.1 Order 2016-0068-DDW, Water Reclamation Requirements

The General Order states that "recycled water use shall not cause unacceptable groundwater and/or surface water degradation," which is mitigated by storing recycled water in unlined ponds (although the applicant would have to line the pond if required by the Regional Board), limiting the application of recycled water to agronomic rates, and controlling the use of recycled water to prevent significant runoff (State Board 2016). The General Order also states that "recycled water shall not create nuisance conditions," which is accomplished by requiring wastewater to be oxidized, preventing airborne spray from entering dwellings, and prohibiting the application of recycled water to saturated soil (State Board 2016).

2.3.2.2 California Water Code Sections 1210-1212, Wastewater Effluent Water Rights

Sections 1210, 1211, and 1212 of the Water Code explicitly address ownership and water rights with respect to treated wastewater. If a water reuse project will decrease the amount of water in a stream or other waterway, the owner of the wastewater treatment plant needs to file a wastewater change petition with the Division of Water Rights. A petition is not needed for changes in the discharge or use of treated wastewater that do not result in decreasing the flow in any portion of a watercourse, or when the discharge is directly to the ocean or a bay.

2.3.2.3 Basin Plan Criteria

The General Order requires recycled water uses to comply with the applicable Basin Plan, which determines beneficial uses of groundwater and surface waters in Santa Clara County. The Basin Plan also includes water quality criteria to help maintain and support those identified beneficial uses. Thus, determination of compliance with the Basin Plan is part of the application process for NPR.

Some examples of the beneficial uses for groundwater and surface waters in Santa Clara County include municipal and domestic supply (MUN), agricultural supply (AGR), industrial process water supply (PROC), and industrial service water supplies (IND). The water quality standards to help maintain the identified beneficial uses for groundwater and surface waters are described in Section 3.2.3.1 and Section 3.3.3.1, respectively.

2.3.2.4 Salt and Nutrient Management Plan Criteria

The General Order considers that, while the use of recycled water for irrigation is not expected to be a significant source of salt loading relative to other sources, it may have the potential to increase salts and other contaminants in groundwater. Thus, it references the Recycled Water Policy, which calls on local water and wastewater utilities to fund and develop SNMPs. The pertinent water quality objectives specific to Santa Clara County are detailed in Chapter 3 of the *San Francisco Bay Basin Plan,* and Chapter 3 of the *Central Coastal Basin Plan*.

2.3.2.5 NPR Use Area Requirements

To support protection of the environment, NPR use area requirements are included in the Title 22 regulations, in Chapter 3, Article 4, "Use Area Requirements." End users of recycled water must understand these requirements and ensure compliance.

2.3.3 Permitting Approaches

Permitting for NPR projects involves obtaining WDRs and/or WRRs. Currently, the most straightforward approach to permitting new NPR projects is to leverage General Order 2016-0068-DDW. Existing NPR projects that were permitted under previous General Orders will not be impacted by this General Order. This section describes the process for those existing projects and outlines the permitting process for new NPR projects.

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2.3.3.1 Existing Projects Under Previous General Orders

The purpose of General Order 2016-0068-DDW is to provide consistent regulation of non-potable uses of recycled water statewide. To provide this consistency, the General Order intended that existing Regional Board general orders or conditional waivers for NPR be terminated by the Regional Board within 3 years of the adoption of the General Order (i.e., by June 2019).

2.3.3.2 Baseline Approach for New Projects

New NPR projects that are seeking a permit under the 2016 General Order must complete the application process, which includes submitting an NOI and Title 22 Engineering Report as described in Attachment A of the General Order.

The NOI must include the following information:

- Facility or waste treatment information.
- Proposed application of recycled water, including estimated amount of water to be used, use type and use area, and a proposed Implementation Plan or Operations and Management Plan. The plan should include specific agronomic rates and nutrient application for the use area(s).
- Description of water recycling program.
- Any additional site-specific conditions.
- Description of water recycling program administration.

The application must also include a Title 22 Engineering Report, and approval of the report must be obtained from the State Board before the Regional Board issues the permit.

Other potentially applicable permits for the permitting process include California Environmental Quality Act (CEQA), CEQA-Plus, and National Environmental Policy Act (NEPA) (as applicable). Any request for modification of existing WDRs must also be reviewed and approved by the appropriate Regional Board.

2.3.3.3 Alternative Approach for New Projects

New NPR projects can apply to the Regional Board for a site-specific order. This option would be needed if the proposed discharge is not consistent with the Basin Plan requirements or any other requirement specified in the 2016 General Order.

2.3.3.4 Monitoring and Reporting Requirements

Monitoring and reporting requirements are described in Attachment B of the 2016 General Order (MRP) and in the Title 22 regulations. The MRP describes the requirements for monitoring a recycled water system. Not all of the monitoring requirements listed may be required of all recycled water projects, and Regional Board staff can be consulted to determine the applicable requirements. The monitoring requirements listed in the 2016 General Order are summarized in Table 2-3.

Table 2-3. Monitoring Requirements for NPR (per 2016 General Order)		
Type of Monitoring	**When Applicable**	**Monitored Constituent(s), Parameter(s), and/or Requirement(s)**
Recycled water monitoring	If recycled water is used for irrigation of landscape areas	• Priority pollutants
Disinfection system monitoring	If disinfection is performed	• Total coliform bacteria [a] • Turbidity [a]
Pond system monitoring	If recycled water storage ponds are used to store recycled water when not needed	• Freeboard • Odors • Berm condition
Use area monitoring	Administrator shall monitor use area(s), which may be delegated to a user; however, reporting responsibilities remain with the administrator	• Recycled water user • Recycled water flow • Acreage applied • Application rate • Soil saturation/ponding • Nuisance odors/vectors • Discharge offsite • Notification signs
Cooling/industrial/other uses of recycled water	If recycled water is used for industrial, commercial cooling, or air conditioning where mist is generated	• Comply with CCR, Title 22, §60306 (c)
Dual-plumbed recycled water systems	If dual-plumbed recycled water systems are proposed	• Cross connection testing • Backflow incident • Backflow prevention device testing and maintenance

a. *Reporting frequency for total coliform bacteria and turbidity is to be determined and specified within the NOA or as required by the CCR.*

Title 22 regulations also mandate sampling requirements for NPR, which are required of the producer or supplier of the recycled water. These requirements are detailed in Title 22, Chapter 3, Article 6, “Sampling and Analysis” and summarized in Table 2-4.

Table 2-4. Sampling Requirements for NPR (per Title 22)	
Category of Recycled Water	**Sampling and Analysis Requirements**
UDS	n/a
DS23	Sampled at least once daily for total coliform bacteria to meet water quality requirements described in Table 3.
DS2.2	Sampled at least once daily for total coliform bacteria to meet water quality requirements described in Table 3.
DT	Sampled at least once daily for total coliform bacteria to meet water quality requirements described in Table 3. Shall be continuously sampled for turbidity by using a continuous meter following filtration to ensure compliance with water quality requirements described in Table 2. • Compliance with daily average operating filter effluent turbidity shall be determined by averaging the levels of recorded turbidity taken at 4-hour intervals over a 24-hour period • Should the continuous turbidity meter fail, grab sampling at a minimum frequency of 1.2 hours may be substituted for a period of up to 24 hours The results of the daily average turbidity shall be reported quarterly to the regulatory agency.

The administrator of the recycled water program is required to submit an Annual Report to the Regional Board by April 1 following the monitoring year. The requirements of the Annual Report are described in Attachment B of the 2016 General Order.

Section 3: Potable Reuse

This section describes PR, including approaches, groundwater recharge regulatory requirements, surface water augmentation regulatory requirements, and DPR.

3.1 Approaches

PR applications exist along a spectrum based on the distance and time of treatment to purified water levels and its ultimate consumption by the public. IPR is characterized by the use of an environmental buffer.

DPR projects are defined by the absence of a significant environmental buffer. California distinguishes two forms of DPR: raw water augmentation (RWA) and treated water augmentation (TWA). Because they do not incorporate environmental buffers, DPR projects will have significantly reduced time to detect and respond to failures or compromises in treatment prior to distribution. As this response time decreases and projects become more direct, different strategies are needed to ensure public health protection.

Generally, as the forms of reuse become more direct, the regulations require higher levels of treatment. In principle, this is to compensate for the protections that are lost by the water spending less time in the environment. This concept is depicted in Figure 3-1, where the level of treatment increases moving from GWR through spreading to TWA. The minimum level of treatment is tertiary filtration and disinfection, and grows with increasing degrees of rigor from groundwater injection to SWA. Both GWR and SWA require full advanced treatment (FAT), which is treatment of the entire flow of water through both reverse osmosis (RO) and an advanced oxidation process (AOP). Given this trend toward higher treatment with greater directness, it is likely that future RWA and TWA regulations will also specify additional treatment beyond the IPR requirements (Olivieri et al. 2016; State Board 2018).

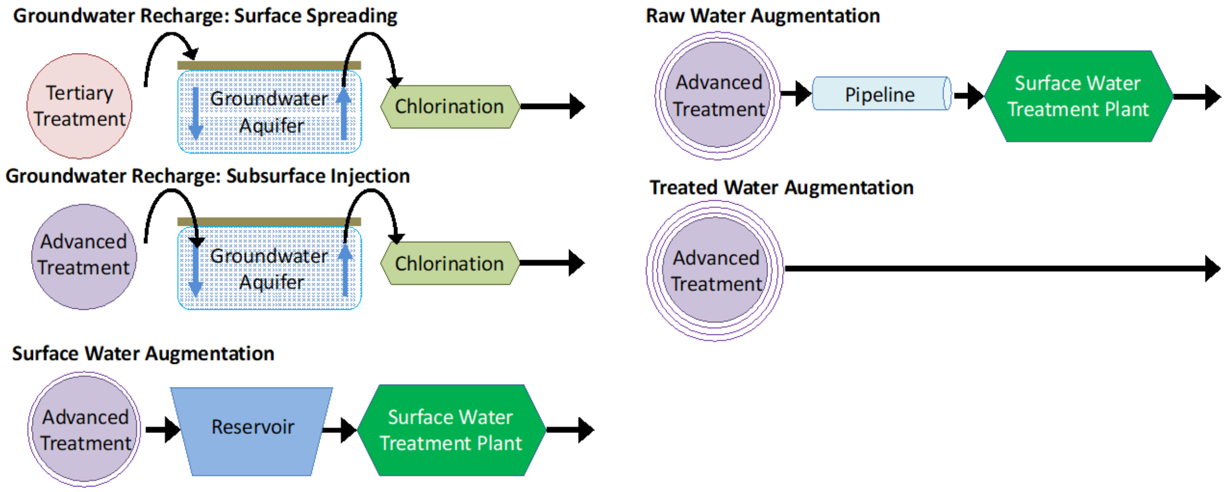
Groundwater Recharge: Surface Spreading
Tertiary Treatment
Groundwater Aquifer
Chlorination
Groundwater Recharge: Subsurface Injection
Advanced Treatment
Groundwater Aquifer
Chlorination
Surface Water Augmentation
Advanced Treatment
Reservoir
Surface Water Treatment Plant
Raw Water Augmentation
Advanced Treatment
Pipeline
Surface Water Treatment Plant
Treated Water Augmentation
Advanced Treatment

Figure 3-1. Forms of potable reuse in California

The following sections describe the regulatory requirements for the various forms of PR, including both the public health and environmental requirements. While containing many prescriptive requirements, the regulations do incorporate a certain degree of flexibility. This flexibility has been and can be used to pursue novel approaches that offer advantages in terms of project size and overall cost. Each section concludes

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with a discussion of this regulatory flexibility, and provides examples of the variety of permitting approaches based on existing and planned California projects.

3.2 Groundwater Recharge Regulatory Requirements

This section describes PR groundwater recharge regulatory requirements, including a regulatory summary, public health criteria, environmental criteria, and permitting approaches.

3.2.1 Regulatory Summary

The surface spreading GWR project at Los Angeles County Sanitation District's (LACSD) Montebello Forebay was the first PR project in California. Fourteen years after this project began (1962), the first draft regulations governing GWR were released (California Department of Health Services 1976). A year later, Water Factory 21 at Orange County Water District (OCWD) became the first subsurface injection GWR project. These two pioneering projects were instrumental in helping regulators understand the risks and control tools needed for reliable, safe PR, and played a large role in shaping the final GWR regulations, which were published in June 2014 (CDPH 2014). The adoption of the final regulations in 2014 was significant in that it provided clear and defined regulatory guidance for agencies interested in GWR. The completion of this regulation was motivated by California Senate Bill (SB) 918, which mandated the finalization of the GWR regulations by December 2013.

The regulations identify two forms of GWR: surface spreading (Title 22, Chapter 3, Article 5.1; Figure) and subsurface injection (Title 22, Chapter 3, Article 5.2). Surface spreading requires that secondary effluents receive a minimum of tertiary filtration and disinfection prior to application of the water to a spreading basin (CDPH 2014). As water percolates through the soil to the aquifer, further control and attenuation of contaminants is provided through soil aquifer treatment (SAT).

Subsurface (or direct) injection projects introduce water directly into the aquifer, and thereby bypass the potential for further treatment through SAT. Accordingly, higher degrees of treatment are required at advanced water treatment facilities (AWTF) to ensure that equivalent qualities of water are extracted and distributed.

The following section describes the key considerations for these two forms of GWR in terms of both public health and environmental protection.

3.2.2 Public Health Criteria

Because the requirements differ for surface spreading and subsurface injection projects, they are divided into two articles: Article 5.1 for Surface Application and Article 5.2 for Subsurface Application (CDPH 2014). Generally, the types of requirements are similar, though the specific details may differ. The major requirements for the two forms of GWR are described in the following sections, with emphasis added to areas in which they differ.

3.2.2.1 Pathogenic Microorganism Control

The public health aspects of the GWR regulations focus first and foremost on minimizing the acute risk of pathogenic microorganisms. Requirements for pathogen control include 12-log reduction of enteric virus, 10-log reduction of *Giardia* cysts, and 10-log reduction of *Cryptosporidium* oocysts. These "12/10/10" requirements must be met using a multiple-barrier approach—for each type of pathogen, a minimum of three treatment processes must be used, with each providing at least 1.0-log, but credited with no more than 6.0-logs, of pathogen removal credit.

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For spreading applications (Figure 3-2), the minimum water quality that can be used for recharge is a filtered, disinfected tertiary recycled water (see Section 2.1). Higher levels of treatment—e.g., FAT—could be used for spreading; however, FAT is not necessary for spreading projects. Any spreading project that provides a minimum of 6 months of retention time is credited with 10-log reduction of both *Cryptosporidium* and *Giardia* (Section 60320.108.c). Furthermore, one log of virus credit is assigned per month of retention time in the aquifer.

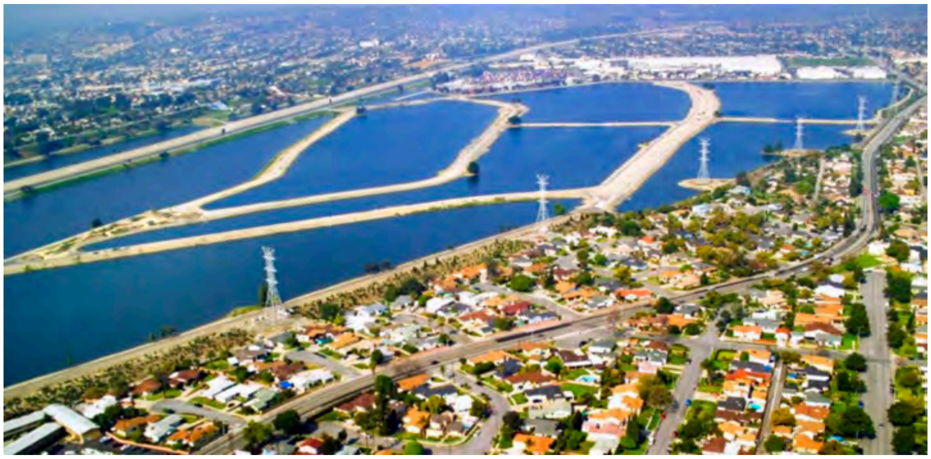

Figure 3-2. Montebello Forebay groundwater recharge spreading basins in Los Angeles County

For subsurface injection, credit for *Giardia* cysts and *Cryptosporidium* oocysts cannot be achieved through aquifer retention time. Consequently, the full log removal requirement for *Giardia* cysts and *Cryptosporidium* oocysts must be accomplished prior to injection. As with spreading projects, virus removal can be accomplished through a combination of treatment at the AWTF and subsurface attenuation. In every case, demonstration of performance or retention time must be provided. For treatment processes used to meet pathogen requirements, projects must validate unit process performance and demonstrate their effectiveness via ongoing monitoring of a surrogate parameter. Furthermore, the retention time underground must be verified using a tracer study under hydraulic conditions representative of normal GWR operations.

3.2.2.2 Advanced Treatment Criteria

One key differentiator between the two forms of reuse is the minimum degree of treatment required. Spreading projects must meet only the Title 22 requirements for disinfected tertiary waters (i.e., oxidation, filtration, and disinfection) given that additional treatment is provided via SAT at the spreading basin. Because groundwater injection does not benefit from SAT, higher degrees of treatment are required at the AWTF. Specifically, groundwater injection requires the use of FAT, or the treatment of the entire flow of water with RO and an oxidation treatment process (Section 60320.201). Most FAT facilities follow the GWR treatment train model using microfiltration (MF), RO, and advanced oxidation via ultraviolet (UV)/hydrogen peroxide (H_2O_2) or UV-hypochlorous acid (HOCl). Because the treatment requirements for subsurface injection are more stringent than surface spreading, water that has been treated through a FAT train can be used for both injection and spreading.

Performance requirements for RO (Figure 3-3) involve demonstrating minimum levels of salt rejection and ensuring that permeate total organic carbon (TOC) remains within specified limits. Initially, RO was considered an absolute barrier to pathogens and chemicals; however, with improving analytical methods, trace organic compounds have been detected in RO permeate. This recognition gave rise to the requirement

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for an AOP following RO. To demonstrate AOP performance, the regulations allow one of two methods to be used. In the first, AOP must be demonstrated to provide minimum removals of a suite of constituents from nine different chemical classes (Section 60320.201.c). The second, and more commonly pursued option, is to demonstrate the ability of AOP to provide 0.5-log reduction of 1,4-Dioxane (CDPH 2014). 1,4-Dioxane was selected because it serves as an indicator of the low molecular weight, uncharged constituents that have been shown to pass through RO; processes that reduce 1,4-Dioxane levels (e.g., AOPs) will also be effective at removing a wide diversity of additional CECs.

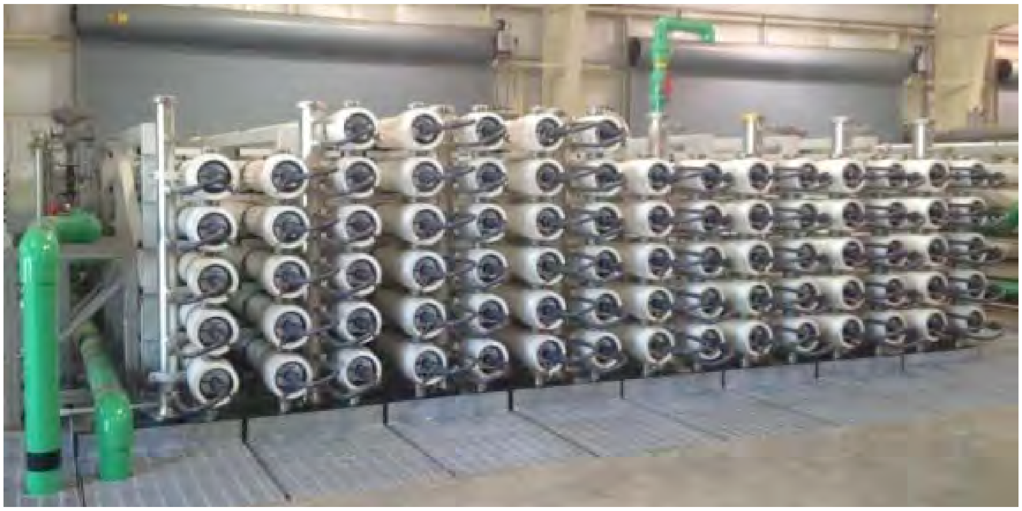

Figure 3-3. Reverse osmosis treatment skid at the Silicon Valley Advanced Water Purification Center

3.2.2.3 Source Control

The recycled water used for GWR projects must be from a wastewater management agency that administers an industrial pretreatment and pollutant source control program. The program must include (1) an assessment of the fate of site-specific chemicals through the wastewater and recycled water treatment systems, (2) monitoring and investigation of chemical sources, (3) an outreach program to manage and minimize the discharge of chemicals into the source water, and (4) an inventory of chemicals that may be discharged into the wastewater collection system.

3.2.2.4 Chemical Control

Chronic and acute risks to public health associated with chemical contaminants are also addressed in the GWR regulations, including nitrogen (N) compounds (Sections 60320.110 and 60320.210), regulated contaminants (Sections 60320.112 and 60320.212), and additional chemical and contaminant monitoring, including various unregulated contaminants (Sections 60320.120 and 60320.220). Total nitrogen must be sampled twice weekly with any exceedances above 10 milligrams per liter (mg/L) as N requiring additional action. As with many constituents, samples can be taken either before or after surface application, i.e., after taking advantage of SAT. Reduced monitoring is possible for projects that show consistently low levels over a 24-month period.

Regulated contaminants—including inorganics, radionuclides, organic chemicals, disinfection by-products (DBP), and lead and copper—must be monitored quarterly. Constituents with secondary maximum contaminant levels (SMCL) must be measured at least once annually. Actions to take in the event of exceedances are also described.

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The additional chemical and contaminant monitoring requirements include (1) the priority toxic pollutants, (2) a list of site-specific, unregulated chemicals that must be determined in conjunction with the State Board, and (3) constituents with notifications levels (NL). The State Board has enlisted a Science Advisory Panel to help develop the list of unregulated contaminants for monitoring. The most recent recommendations were provided in its April 2018 report titled *Monitoring Strategies for Constituents of Emerging Concern in Recycled Water* (Drewes et al. 2018).

3.2.2.5 Diluent Water and Recycled Wastewater Contribution

Many spreading projects will require dilution with other waters (diluent water) to meet the water quality requirements of the regulations (particularly spreading projects that do not use FAT). The criterion for determining the amount of diluent water required is TOC; ultimately, no more than 0.5 mg/L of TOC from the recycled water may be present in the blended groundwater. The regulations specify minimum water quality requirements for diluent water, and also require that sponsors develop a method to demonstrate the volume of diluent water provided.

The TOC of the recycled water sets the maximum percentage of recycled water that can be blended into the groundwater. The formula for the maximum recycled water contribution (RWC) is:

$$Recycled\ water\ contribution\ (RWC) = \frac{0.5\ mg/L}{TOC\ in\ recycled\ water\ (in\frac{mg}{L})}$$

If a recycled water has a TOC of 2.5 mg/L, for example, the maximum RWC would be 0.5 mg/L divided by 2.5 mg/L, or 20 percent. Such a project would need to provide diluent water to constitute the remaining 80 percent of the total water. The initial RWC for SAT is no greater than 20 percent based on a running monthly average RWC using the total volume of recycled municipal wastewater and credited diluent water over the past 120 months. Provisions exist to increase RWC from this initial 20 percent, but levels exceeding 50 percent require special permission.

While RWC requirements are also present in the groundwater injection regulations (Section 60320.216), they are much less limiting for PR systems employing the FAT process. This is a consequence of the FAT requirement for RO treatment, which must continuously meet concentrations not exceeding 0.5 mg/L of TOC. Accordingly, FAT projects can typically comply with Section 60320.16.c, which allows for an initial maximum RWC of 1.0 (i.e., no dilution) because the project can reliably achieve TOC concentrations no greater than 0.5 mg/L.

3.2.2.6 Response Retention Time

Per Sections 60320.124 (spreading) and 60320.224 (injection), recycled water applied by a GWR project must be retained underground for a minimum of two months to allow a project sponsor sufficient response time to identify treatment failures and implement actions, including the plan to provide an alternative water supply or wellhead treatment. To demonstrate that the actual retention time underground is no less than that required, an added tracer or a DDW-approved intrinsic tracer must be used. For each month of retention time estimated using the approved intrinsic tracer, a project sponsor shall receive no more than 0.67-month credit. The actual retention time is the time representing the difference between when the water containing the tracer is applied and when either 2 percent of the initially introduced tracer concentration has reached the downgradient monitoring point, or 10 percent of the peak tracer unit value arrives at the downgradient monitoring point.

For planning purposes, modeling may be used to estimate the retention time provided by an aquifer. For each month of retention time estimated using modeling, the recharge water may be credited with no more than either (1) 0.5-month credit for numerical modeling, or (2) 0.25-month credit for analytical modeling (as defined in Table 60320.124).

3.2.2.7 Alternatives

One aspect of the regulations that allows for flexibility in the aforementioned requirements is the alternatives clause (Sections 60320.130 and 60320.230). The clause offers broad freedom to use alternatives, as long as the alternatives (1) are demonstrated to be equally or more protective of public health, (2) receive written approval from DDW, and (3) have been discussed in a public hearing. To help DDW assess the alternatives, an independent advisory panel (IAP) is typically required to assess the public health protection that will be provided. The IAP must be composed of a toxicologist, geologist/hydrogeologist, an engineer with at least 3 years of experience in wastewater treatment and public drinking water supply, a microbiologist, and a chemist.

3.2.2.8 Other Criteria

The regulations for GWR through surface spreading and subsurface injection are different because of the loss of SAT when the water is injected directly. However, the major requirements designed to ensure high water quality and protection of public health are the same, and are summarized in Table 3-1.

Table 3-1. Summary of Additional Criteria for Groundwater Replenishment Reuse Applications

Requirement	Description
General requirements (§60320.100 and §60320.200)	Describes compliance report that must accompany all projects showing ability to meet the requirements of the regulation; specifies requirements for alternative water supplies, and aquifer water quality and hydrogeological characterization, including zone of controlled drinking water well construction; demonstration of technical, managerial, and financial (TMF) capabilities; approvals needed to recommence a project that has been suspended
Public hearing (§60320.102 and §60320.202)	Required for the initial permit and whenever there is a proposal to increase the maximum recycled municipal wastewater contribution
Laboratory analysis (§60320.104 and §60320.204)	Must be performed by certified labs approved by DDW using DDW-approved drinking water methods
Operations plan (§60320.122 and §60320.222)	Operation Optimization Plan must be submitted to DDW prior to startup that identifies and describes operations and maintenance (O&M), monitoring, and analytical methods for the groundwater replenishment reuse project (GRRP) to meet the requirements of the groundwater replenishment regulations
Reporting (§60320.128 and §60320.228)	Annual report must be submitted to DDW within 6 months of the end of each calendar year; engineering reports must be updated at least once every 5 years

3.2.3 Environmental Criteria

Recycled water discharges to groundwater in Santa Clara County are regulated by either the SFB Regional Board or the CC Regional Board. WDRs/WRRs for GWR will ensure compliance with the following regulations:

- All relevant articles from California Title 22, Chapter 3: Recycled Water Criteria
- Monitoring requirements for priority pollutants and CECs laid out in the Recycled Water Policy
- Water quality objectives identified in the SFB Basin Plan or the CC Basin Plan, as applicable (depending upon location)
- Water quality objectives and implementation policies established in Valley Water's Groundwater Management Plan and the SNMPs for the Santa Clara and Llagas subbasins

Permit limits for groundwater replenishment projects are set to ensure that GWR project discharges do not adversely affect beneficial uses or degrade water quality. Criteria governing discharge water quality to the environment are contained in the Basin Plan and SNMPs.

3.2.3.1 Basin Plan Criteria

The SFB and CC Basin Plans identify both narrative and numeric objectives for groundwater; these objectives are supplemented with basin-specific and/or site-specific objectives as needed. The primary objective for the groundwater quality standards is to maintain the existing high quality of groundwater in the region.

The following standards are specified for beneficial use of the groundwater:

- Total coliform (MUN): 7-day median < 1.1 MPN)100 (mL (SFB Basin Plan) or < 2.2 MPN/100 mL (CC Basin Plan)
- Organic and inorganic chemicals (MUN): At a minimum, groundwater designated for use as domestic or municipal supply must comply with drinking water maximum contaminant levels (MCLs) and SMCLs established in the following provisions of Title 22: Table 64431-A of Section 64431 (inorganic chemicals), Table 64433.2-A of Section 64433.2 (fluoride), Table 64444-A of Section 64444 (organic chemicals), Tables 64449-A and 64449-B of Section 64449 (SMCLs: consumer acceptance limits)
- AGR: Additional water quality objectives are specified for agricultural use, including livestock watering. These are specified in Table 3-6 of each Basin Plan
- Radioactivity (MUN): At a minimum, groundwater designated for use as domestic or municipal supply must comply with drinking water MCLs and SMCLs established in the following provisions of Title 22: Table 64442 of Section 64442 and Table 64443 of Section 64443 (radionuclides)
- Taste and odor: Groundwater designated for MUN use must not contain taste- or odor-producing substances in concentrations that cause a nuisance or adversely affect beneficial uses

3.2.3.2 Salt and Nutrient Management Plan Criteria

The SNMPs for the Santa Clara and Llagas subbasins set basin-specific water quality objectives based on the objectives identified in the applicable Basin Plan. Water quality objectives for total dissolved solids (TDS), nitrate (NO_3), nitrite, and nitrate + nitrite are specified (Table 3-2).

Table 3-2. Salt and Nutrient Management Plan Water Quality Objectives for the Santa Clara and Llagas Subbasins (Regional Board, CC Region 2017; Regional Board, SFB Region 2017)

Parameter	Unit	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	
			Santa Clara Subbasin	Llagas Subbasin
TDS	mg/L	500	10,000	450
Nitrate	mg/L as NO_3	45	--	--
Nitrate and nitrite	mg/L as N	10	30	100 [a]
Nitrite	mg/L	--	--	10 [a]

a. For livestock watering.

Note: MUN objectives are the same for the both subbasins.

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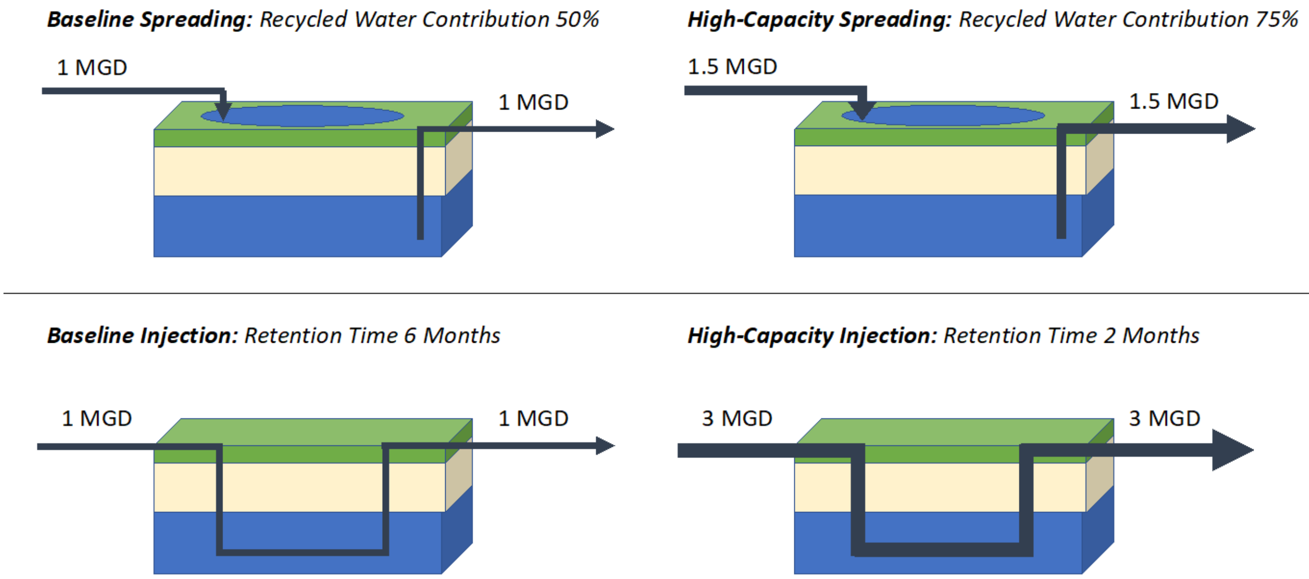
3.2.4 Permitting Approaches

This section describes permitting approaches to PR groundwater recharge regulatory requirements. For both spreading and injection, a baseline approach is described that entails meeting the standard requirements of the regulations (described above). Alternative permitting approaches are also described for both types of projects that would allow for larger project capacities; these are described here as “high-capacity” approaches. There are no separate regulations for high-capacity projects; however, these approaches use innovative strategies to go beyond the standard requirements of the regulations. A summary of the baseline and high-capacity approaches for both spreading and injection is provided in Figure 3-4; these approaches will be further discussed in the following sections.



Baseline Spreading: *Recycled Water Contribution 50%*

High-Capacity Spreading: *Recycled Water Contribution 75%*

Baseline Injection: *Retention Time 6 Months*

High-Capacity Injection: *Retention Time 2 Months*

Figure 3-4. Summary of baseline and high-capacity permitting approaches for groundwater recharge via spreading and injection

All flow values are used solely as examples to illustrate the potential difference between baseline and high-capacity flows.

3.2.4.1 Baseline Approach

One of the hallmarks of the GWR regulations is the requirement for significant aquifer retention times. In addition to further treating the recycled water, the water’s passage through the aquifer provides time to respond to and correct any issues that may have occurred in upstream treatment. Accordingly, GWR projects are structured to both prevent failures from happening (through multiple elements including source control, treatment, monitoring, and operations), while also providing time to respond to failures were they to arise. Projects that provide a balanced mixture of both failure prevention (treatment, monitoring, etc.) and failure response (retention time) elements will likely be the easiest to permit. Typical permit requirements for spreading and injection projects are summarized in Table 3-3.

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Table 3-3. Typical Permit Requirements for Groundwater Recharge Projects

Project Type	Aboveground Treatment	Dilution	Aquifer Retention Time
Spreading	Tertiary filtration and disinfection	Initial RWC ≤ 20% Ultimate RWC ≤ 50%	≥ 6 months
Injection	Full advanced treatment	None required	> 6 months

Groundwater Spreading. For projects spreading tertiary disinfected recycled water, the regulations grant 10-log credit for *Giardia* and for *Cryptosporidium* if the aquifer retention time is at least 6 months. Thus, spreading projects are typically permitted with a combination of moderate degrees of treatment coupled with the provision of significant (6 months or greater) aquifer retention time.

Spreading with disinfected tertiary recycled water is frequently limited by low RWC levels; the baseline permitting approach involves a maximum RWC of 50 percent. In this case, significant diluent water is required to reduce the blended water TOC. This high dilution requirement can limit the size of the recycled water project, particularly if significant diluent water is not available.

Groundwater Injection. Given the requirement for FAT, groundwater injection projects offer significantly more barriers to pathogenic microorganisms. Consequently, FAT projects are less reliant on the aquifer to help meet the pathogen credits. In fact, most facilities that provide a combination of MF, RO, and UV-AOP can meet the 10-log requirement for both *Giardia* and *Cryptosporidium*. The pathogen that tends to drive the aquifer retention time requirement is virus, which does not typically meet the 12-log target through FAT alone. Although most FAT projects do not require 6 months of retention time, they use large basins that provide multiple months to years of travel time to the nearest well. Thus, the baseline permitting approach is characterized by the provision of both a high degree of treatment (FAT) and significant retention times (6+ months).

3.2.4.2 Alternative Approach for High-Capacity Injection Projects

One factor that can limit the capacity of groundwater injection projects, assuming factors such as hydraulic conductivity do not limit flow through the aquifer, is the size of the available aquifers. As the aquifer size decreases, the retention time available for a given flow rate also decreases. Many of the groundwater injection projects in the Los Angeles region have access to large basins that allow them to easily provide long (6+ months) retention times for both groundwater injection and spreading. In other regions of the state, however, projects may be constrained by aquifers whose size may impact the ability to provide the long retention times (Lau et al. 2016). One option for these projects to maximize their capacity is to seek regulatory approval for shorter aquifer retention times.

For a given aquifer size (or volume, *V*), the largest project capacity (or flow, *Q*) can be achieved by minimizing the retention time in the ground (*t*). If retention time is calculated as $t = V/Q$, then project capacity (*Q*) can be optimized according to the equation $Q = V/t$. By setting *t* to its minimum value (2 months), *Q* is maximized. While the regulations allow retention time as low as 2 months, DDW has stated that projects should not assume that they will easily be permitted to operate under these conditions. Box 1 (see page 21) describes the steps taken by the first injection project to receive conceptual approval for a 2-month retention time. The intent is to demonstrate the level of effort needed to pursue a more challenging permitting approach.

The general configuration of public health protections provided by the GWR regulations is illustrated in Figure 3-5 a. In general, PR systems protect public health by balancing a combination of treatment, monitoring, and retention time. If the retention time component becomes shortened, this three-legged stool becomes unbalanced, and may threaten public health. One approach is to compensate for shorter retention time by augmenting both the treatment and monitoring provided (Figure 3-5 b).

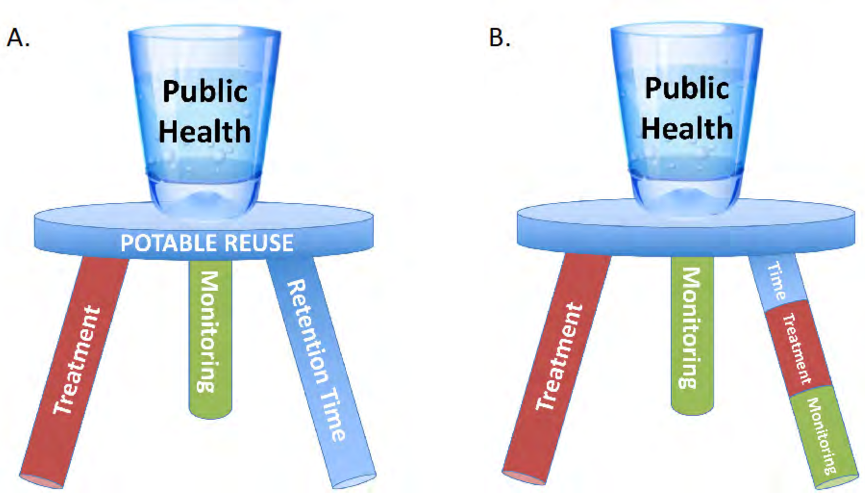

Figure 3-5. Public health protections provided by groundwater recharge projects with (a) baseline permitting approaches, and (b) alternative permitting approaches

The example below of the Padre Dam Municipal Water District (Padre Dam) is of relevance to Valley Water for multiple reasons, including the recent work undertaken by the City of San José to obtain DDW approval for free chlorine disinfection of its recycled water. Based on the Padre Dam experience, there is a template for permitting short retention time projects that relies on enhanced treatment and monitoring. One option for increasing the pathogen control of the standard FAT process (particularly to achieve needed virus credits) is free chlorine disinfection. While the City of San José did not have PR as an explicit driver for its study, the credit that DDW is anticipated to give its NPR system will be applicable for crediting a PR facility. Leveraging this work may offer a cost-effective way to open the door to alternative permitting approaches if needed.

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Box 1
Padre Dam Municipal Water District High-Capacity Injection Project

Padre Dam is the first groundwater injection project to receive conceptual approval from DDW to operate at the 2-month retention time (DDW 2017a). The first step in this permitting approach was to identify additional pathogen credits that could be leveraged. One option was to add an additional treatment process, though this approach entails both higher capital and operational expenses. Padre Dam's approach was to seek regulatory approval to receive additional credits for the chlorine disinfection process at its water recycling facility. Furthermore, Padre Dam offered to enhance the monitoring of its system; by increasing the frequency of monitoring for some key parameters, Padre Dam became less dependent on the aquifer for *time* to detect and respond to issues. The general approach was developed and presented to both a National Water Research Institute (NWRI)-led IAP and DDW. With the consent of the IAP and DDW, Padre Dam's project team developed a testing plan for a year-long demonstration study. The goal of that study was to develop the data needed to permit and design the future full-scale GWR system.

Based on feedback from the IAP and DDW and per the testing plan, a 0.1-mgd demonstration facility was designed and constructed (Figure 3-6). One of the key goals of the project was to demonstrate the effectiveness of a free chlorine disinfection approach to achieve higher virus reduction credits. This entailed designing and testing a free chlorine control system using multiple rounds of virus challenge testing. As a result of this effort, DDW gained confidence that a well-designed and operated system could achieve significant virus inactivation (5+ log of inactivation) and that a control system could be used to continuously maintain that pathogen barrier. Based on this study, DDW granted conceptual approval for the free chlorine approach that is integrated into the full-scale design. The results of the free chlorine study and the other elements of the test plan were presented to the IAP and DDW at the end of the year-long testing period. Based on the findings, the IAP endorsed the project and determined that the approach justified a reduction of the response retention time to the 2-month minimum. On March 24, 2017, DDW gave conceptual approval for Padre Dam's GWR project with the minimum 2-month retention time—the first project to receive such approval.

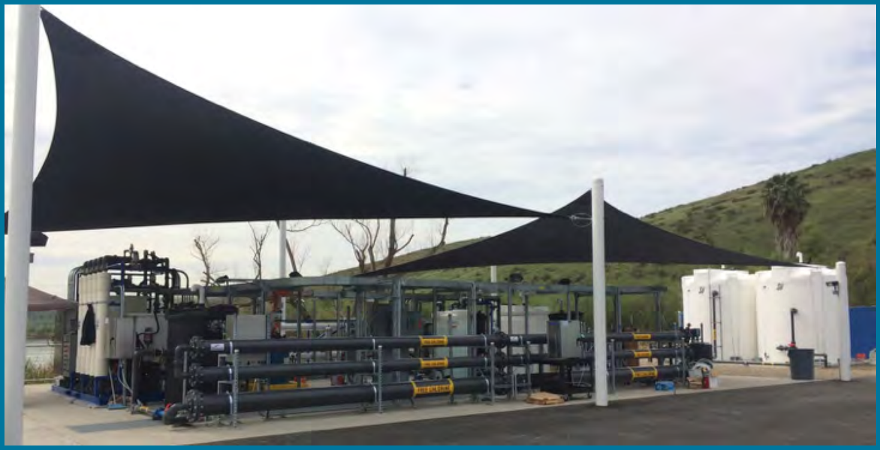

Figure 3-6. Padre Dam 0.1-mgd demonstration facility

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3.2.4.3 Alternative Approach for High-Capacity Spreading Projects: Case Study 2

As discussed in Section 3.2.2, one of the major factors limiting the capacity of spreading projects is the requirement to reduce (through dilution) the concentration of recycled water TOC to the 0.5 mg/L level. Based on the RWC calculation, a well-treated tertiary disinfected recycled water with 5 mg/L of TOC would need to be diluted 10-to-1 with diluent water (10 percent recycled water, 90 percent diluent water). One way to increase project capacity, therefore, would be to develop strategies to further reduce the TOC of the recycled water. Box 2 describes the work being done by the Los Angeles Bureau of Sanitation (LASAN) to increase the capacity of its spreading basins.

Box 2
Los Angeles Bureau of Sanitation High-Capacity Spreading Project

LASAN is pursuing a strategy to increase the capacity of its spreading basins. LASAN’s approach is to optimize the biodegradability of the recycled water (through ozone treatment), drive down the TOC through biodegradation (both with biological activated carbon [BAC] and SAT), and thereby increase the RWC. LASAN designed and constructed a demonstration facility that uses ozone (in lieu of chlorine) to satisfy the pathogen reduction requirements of Title 22 (Figure 3-7). An added benefit of ozone over chlorine is that it is capable of rendering organic material (i.e., TOC) more amenable to biological degradation. In essence, the ozone cleaves larger, more refractory organics into smaller constituents that are more easily consumed by microbiological populations.

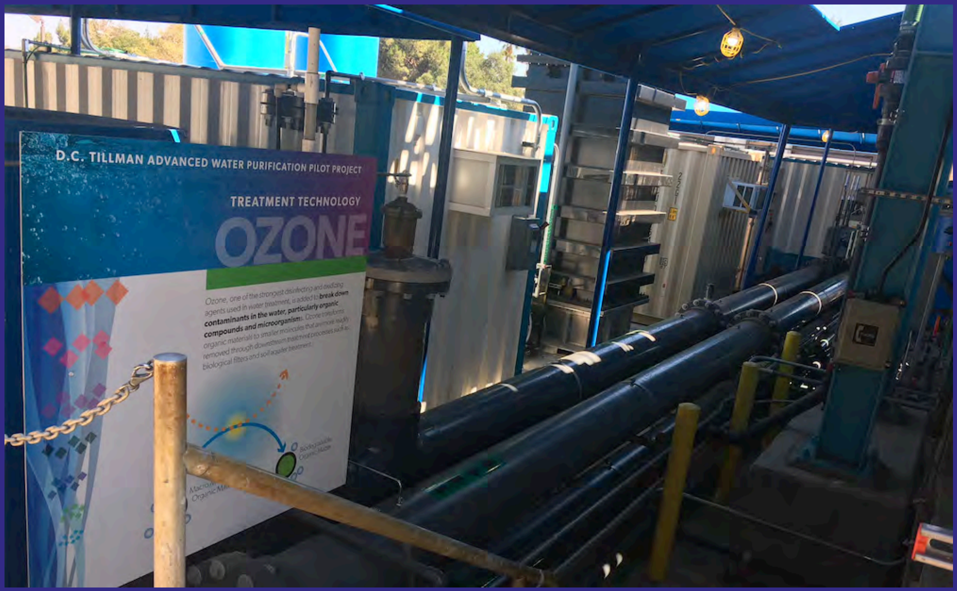

Figure 3-7. Ozone treatment system at the Donald C. Tillman Advanced Water Purification Pilot project

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The GWR spreading regulations set limits on the initial RWC that projects must meet, but offer pathways for alternative, higher RWCs if equal levels of public health protection can be demonstrated. This approach has been studied in past research projects and is of interest for multiple agencies in Southern California, including the Upper San Gabriel Valley Municipal Water District. Such an approach offers ways to maximize project capacity while using a lower-cost, non-RO-based treatment train.

3.3 Surface Water Augmentation Regulatory Requirements

This section describes SWA regulatory requirements, including a regulatory summary, public health criteria, environmental criteria, and permitting approaches.

3.3.1 Regulatory Summary

SWA refers to the planned placement of recycled water into a surface water reservoir used as a source of domestic drinking water supply. Final SWA regulations were released in 2018 with an effective date of October 1, 2018. The following discussion provides an overview of the provisions most relevant to agencies considering implementing an SWA project.

3.3.2 Public Health Criteria

Many of the requirements for SWA projects are similar to those required under the GWR regulations. Key provisions of the SWA regulation include pathogenic microorganism control, chemical control, treatment and monitoring requirements, source control, and reservoir requirements. Reservoir requirements—including dilution and retention time—are discussed first because they impact the degree of treatment required.

3.3.2.1 Dilution Criteria

In SWA, the reservoir itself plays an important role in public health protection. The first benefit of the reservoir is its ability to provide *dilution.* Dilution mitigates contamination by reducing the concentration of compounds present in the recycled water. The dilution and mixing criteria in the SWA regulations require that water withdrawn from the reservoir contains no more than either of the following:

- 1 percent, by volume, of recycled municipal wastewater that was delivered to the reservoir during any 24-hour period
- 10 percent, by volume, of recycled municipal wastewater having been subjected to additional treatment producing no less than an additional 1-log reduction of enteric virus, *Giardia* cysts, and *Cryptosporidium* oocysts

A scenario wherein 1 percent of the withdrawn water is composed of recycled wastewater corresponds to a 100:1 dilution of the recycled water in the reservoir. Similarly, a withdrawal composed of 10 percent recycled water corresponds to 10:1 dilution in the reservoir.

The minimum level of dilution (100:1 or 10:1) must be provided under all conditions. Hydrodynamic modeling is required to identify the worst-case combination of a variety of conditions (e.g., stratification, wind speed and direction, temperature) and ensure that under these conditions, the dilution requirement is still met. Tracer studies are also required to further calibrate and improve the modeling, both prior to and within 6 months of augmentation (see Figure 3-8). The regulations specify that an IAP assist DDW by reviewing and approving the results of this modeling. No pathogen log removal credits are given for time spent or dilution achieved in the reservoir.

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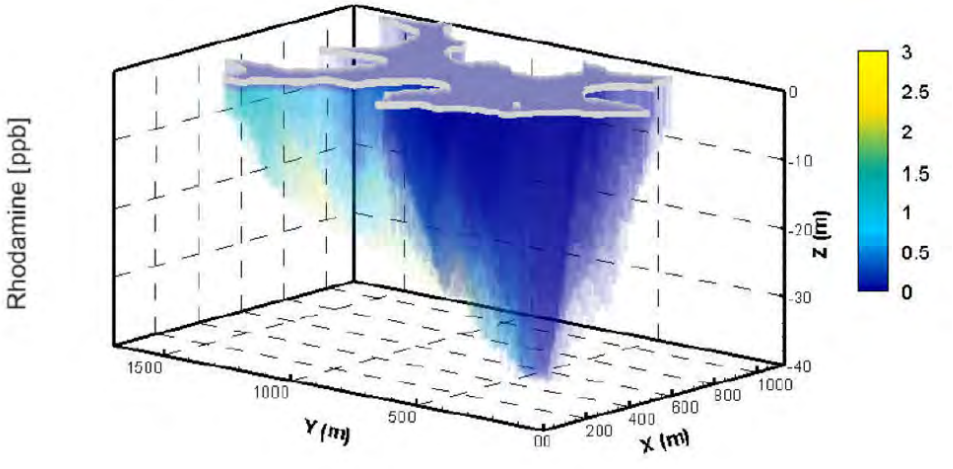

Figure 3-8. Example of a hydrodynamic model replicating a tracer study

Source: Flow Science, 2018.

3.3.2.2 Theoretical Retention Time Criteria

In addition to providing dilution, SWA reservoirs must provide a minimum theoretical retention time, defined as the total volume in the reservoir at the end of a month (V) divided by the total flow out of the reservoir during that month (Q). Per the regulations, the initial theoretical retention time (V/Q) of all projects must be no less than 180 days (6 months). The regulations do allow for alternative theoretical retention times: projects can request alternatives as low as 120 days (4 months) without additional treatment requirements, and as low as 60 days (2 months) with the provision of additional treatment. Projects providing less than a 60-day V/Q would not meet the SWA regulations and would, therefore, be considered DPR projects.

3.3.2.3 Treatment Requirements

The treatment criteria specify requirements for the baseline degree of treatment that must be provided at the AWTF. In brief, SWA requires FAT consisting of RO and AOP with specific requirements for treatment performance and surrogate monitoring.

3.3.2.4 Pathogenic Microorganism Control

Pathogen log reduction requirements are dependent on both the dilution and theoretical retention time achieved in the reservoir (discussed above). The SWA regulations allow pathogen credits to be achieved at both the WWTP and AWTF prior to the reservoir, as well as through subsequent treatment at the drinking water treatment facility (DWTF). The regulations require post-reservoir treatment at a DWTF in compliance with the Surface Water Treatment Rules, i.e., one that achieves a minimum 4/3/2 log reduction of virus, *Giardia,* and *Cryptosporidium*, respectively. The remaining credits must be achieved at the WWTP and AWTF, with the regulations specifying two levels of treatment based on the degree of dilution provided by the reservoir:

1. For projects achieving a minimum 100-fold dilution of the recycled water, the total amount of treatment required is 12/10/10 for virus, *Giardia,* and *Cryptosporidium (V/G/C)*. This translates to a minimum of 8/7/8 being achieved through the WWTP and AWTF (assuming the DWTF will provide 4/3/2). Treatment must be provided by at least two separate treatment processes, each achieving at least 1-log reduction, with no more than 6-log credit for any process.

2. For projects achieving a minimum 10-fold dilution of the recycled water, an additional 1-log pathogen reduction through treatment is required prior to the reservoir. In other words, the WWTP and AWTF must provide a minimum of 9/8/9 for an overall total log removal requirement of 13/11/11. Treatment must be provided by at least three separate treatment processes, each achieving at least 1-log reduction, with no more than 6-log credit for any process.

In addition to dilution, the project's theoretical retention time also impacts the degree of treatment required. Additional treatment is required whenever a project proposes a minimum theoretical retention time of less than 120 days. The regulations require "no less than one $\log_{10}$ reduction" beyond what would otherwise be required based on the treatment and dilution provided. Table 3-4 summarizes the treatment requirements for SWA projects depending on the dilution and theoretical retention time in the reservoir.

Table 3-4. Summary of Treatment, Dilution, and Theoretical Retention Time Criteria for SWA

Dilution	V/Q (days)	Log Removal Credit (V/G/C)		Number of Treatment Processes	Additional Considerations
		WWTP/AWTF	Total		
100:1	≥180	8/7/8	12/10/10	2	--
	<180–120	8/7/8	12/10/10		State Board approval
	<120–60	≥9/8/9	≥13/11/11		State Board approval
10:1	≥180	9/8/9	13/11/11	3	--
	<180–120	9/8/9	13/11/11		State Board approval
	<120–60	≥10/9/10	≥14/12/12		State Board approval

Augmentation must be suspended if the log reduction of any of the regulated pathogens drops more than two logs below the required levels for more than 4 consecutive hours, or for a total of 8 hours in a week. Written approval from the State and Regional Boards is required to reinstate production after a suspension.

3.3.2.5 Source Control Requirements

The source control requirements for SWA are the same as those for GWR projects. The wastewater management agency participating in the SWA project must maintain an industrial pretreatment program and a source control program that includes the following:

- An assessment of the fate of State and Regional Board-specified contaminants through both the wastewater and recycled wastewater treatment systems
- Source investigations and monitoring focused on State- and Regional Board-specified contaminants
- An outreach program to industrial, commercial, and residential communities in areas that supply the SWA project with wastewater for managing and minimizing contaminants at the source
- A current inventory of all contaminants assessed in this program, including any new contaminants that result from the introduction of new sources or changes to existing sources

The regulations for source control for SWA projects are more detailed and complex than those for pretreatment under NPDES permits. They are differentiated primarily by the focus on providing a barrier for the protection of human health, rather than focusing on the quality of wastewater discharged (i.e., environmental health). Additionally, source control programs give wastewater agencies the authority to regulate residential discharges, which is not afforded under pretreatment programs. Each wastewater agency that would be a source of recycled water to the SWA project would need to consider the feasibility and expense of implementing a source control program.

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3.3.2.6 Alternatives

Chapter 3 of the SWA regulations includes an “alternatives clause” (Section 60320.330) that allows project sponsors to apply for alternatives to any of the requirements in Chapter 3. Alternatives require written consent from the State Board and must demonstrate that they provide an equal or better degree of public health protection. While broad in concept, it is unlikely that certain requirements will have much flexibility—e.g., the use of RO in the treatment train—though this clause could have implications for other project aspects. An IAP must be convened to approve alternative projects and there may be a need to conduct a public hearing to disseminate information if requested by the State Board.

The broad clause in Chapter 3 does not extend to Chapter 17. The only section in Chapter 17 that allows for flexibility is the allowance for “alternative” theoretical retention times (refer to Section 3.3.2.2). The approval of an IAP may be required for alternative theoretical retention times.

3.3.2.7 Other

Beyond the aforementioned topics, the regulations specify requirements for a number of additional elements. A summary of the requirements in each article of the relevant regulations is shown in Table 3-5.

Table 3-5. Chapter 3. Article 5.3. Indirect Potable Reuse: Surface Water Augmentation

Section	Title	Description
60320.301	General Requirements	Includes development of a joint plan between water recycling agency and public water system; demonstration of “technical, managerial, and financial” capability; compliance
60320.302	Advanced Treatment Criteria	Requirements for FAT, process monitoring, demonstration testing, reporting
60320.304	Lab Analyses	Laboratory requirements for analysis of chemicals, both with and without MCLs
60320.306	Wastewater Source Control	Requirements for source control program
60320.308	Pathogenic Microorganism Control	Requirements for virus, *Giardia*, and *Cryptosporidium* removal through the advanced treatment process; options for alternative levels of treatment; responses to failures
60320.312	Regulated Contaminants and Physical Characteristics Control	Requirements for monitoring of various groups of regulated chemical contaminants; response to exceedances; monitoring
60320.320	Additional Chemical and Contaminant Monitoring	Requirements for additional chemical testing and reporting, including NLs and other contaminants of concern
60320.322	SWSAP Operation Plan	Identifies plan requirements including operations, maintenance, analytical methods, monitoring, reporting, and ongoing training
60320.326	Augmented Reservoir Monitoring	Monitoring requirements at the reservoir, including sampling locations and frequency
60320.328	Reporting	Includes results of monitoring, operations summary, responses to failure events
60320.330	Alternatives	Permits use of alternatives that provide equivalent or better protection of public health; requirements for approval of alternatives
Chapter 17. Article 9. Indirect Potable Reuse: Surface Water Augmentation		
Section	Title	Description
64668.10	General Requirements and Definitions	Includes definitions, permit requirements, and other elements related to Article 5.3, Chapter 3; requirements for reservoir
64668.20	Public Hearings	Requirements for public interaction, including meetings, Web-accessible information, and customer notifications
64668.30	SWSAP Augmented Reservoir Requirements	Requirements for reservoir as approved surface water supply; retention time requirements; tracer study and modeling requirements; dilution requirements

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3.3.3 Environmental Criteria

This section describes environmental criteria for SWA.

3.3.3.1 Basin Plan Criteria

The reservoirs of Santa Clara County encompass several beneficial uses, as defined in the SFB Basin Plan:

- Municipal and domestic supply (MUN)
- Agricultural supply (AGR)
- Groundwater recharge (GWR)
- Commercial and sport fishing (COMM)
- Cold freshwater habitat (COLD)
- Fish migration (MIGR)
- Fish spawning (SPWN)
- Warm freshwater habitat (WARM)
- Wildlife habitat (WILD)
- Water contact recreation (REC-1)
- Non-contact water recreation (REC-2)

The SFB Basin Plan contains both narrative objectives and numerical water quality objectives. The combination of these objectives defines the level of water quality that must be maintained within the region. If water quality in a reservoir is better than that prescribed by the SFB Basin Plan, the state Antidegradation Policy (described below) applies.

Narrative Water Quality Objectives

The SFB Basin Plan contains narrative water quality objectives for the following parameters: bioaccumulation, biostimulatory substances, color, floating materials, oil and grease, population and community ecology, radioactivity, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, toxicity, and turbidity. In general, the narrative water quality objectives specify that constituents not be present at levels that cause nuisance or adversely affect beneficial uses.

Numerical Water Quality Objectives

The SFB Basin Plan specifies numerical water quality objectives for several constituents. Bacteriological standards are summarized in Table 3-6 for recreational and municipal water uses. Additional objectives are summarized below.

Table 3-6. Water Quality Control Plan for the SFB Basin Bacterial Criteria for Relevant Beneficial Uses

Beneficial Use	Fecal Coliform (MPN/100 mL)	Total Coliform (MPN/100 mL)
Water contact recreation (REC-1)	Geometric mean < 200 90th percentile < 400	Median < 240 No sample > 10,000
Non-contact water recreation (REC-2)	Mean < 2,000 90th percentile < 4,000	--
Municipal supply (MUN)	Geometric mean < 20	Geometric mean < 100

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Dissolved oxygen:

- Cold water habitat: 7.0 mg/L minimum
- Warm water habitat: 5.0 mg/L minimum
- pH: must remain between 6.0 and 8.5. Controllable water quality factors shall not cause changes greater than 0.5 unit in ambient pH levels.
- Temperature: The temperature of any cold or warm freshwater habitat shall not be increased by more than 5 degrees Fahrenheit (°F) (2.8 degrees Celsius [°C]) above natural receiving water temperature. Cold freshwater habitats support trout and may support anadromous salmon and steelhead. They are often well-oxygenated and fed by soft waters, making fish more susceptible to toxic metals. Warm freshwater habitats support bass, bluegill, perch, and non-fish species, such as frogs, crayfish, and insects. Warm freshwater habitats are generally lakes and reservoirs, though some minor streams may serve this purpose.
- Un-ionized ammonia:
  - Annual median < 0.025 mg/L
  - Maximum, Central Bay = 0.16 mg/L
  - Maximum, Lower Bay = 0.4 mg/L
- MCLs: To protect the MUN beneficial use designation, SFB Basin Plan water quality objectives for regulated chemicals are established at the corresponding drinking water MCLs and sMCLs as described in Section 3.2.3.1. It is noteworthy that, while the MCLs established in the CCR apply to the final treated potable supply delivered to potable water customers, the SFB Basin Plan applies these MCLs directly to the raw (untreated) water stored in surface water reservoirs used for municipal supply.

3.3.3.2 California Toxics Rule

The U.S. Environmental Protection Agency (EPA) promulgated the *California Toxics Rule* (CTR) in 2000 (EPA 2000). The CTR establishes water quality standards for toxic constituents for inland surface waters of California.[1] CTR standards apply to regulated surface waters with public water supply and aquatic life beneficial use designations. Applicable CTR receiving water standards include:

- Short-term (1-hour) criterion maximum concentration (CMC) standards for the protection of freshwater habitat from acute effects
- Longer-term (4-day) criterion continuous concentration (CCC) standards for the protection of freshwater habitat from chronic effects
- Longer-term (chronic) public health standards for the consumption of water and organisms

CTR receiving water standards for the protection of aquatic habitat include standards for dissolved metals, cyanide, pentachlorophenol, polychlorinated biphenyls (PCB), and chlorinated pesticides. CTR standards for the protection of human health (consumption of water plus organisms) include standards for dissolved metals, cyanide, asbestos, dioxins and furans, volatile organic compounds, acid-extractable compounds, base neutral compounds, PCBs, chlorinated pesticides, and DBPs.

The State Board in 2000 adopted the State Implementation Policy (SIP) to provide standardized guidance to Regional Boards for regulating discharges of toxic substances to receiving waters.[2] The SIP establishes

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[1] CTR standards are established within Title 40, Section 131.38 (40 CFR 131.38) of the *Code of Federal Regulations*.

[2] Procedures for CTR implementation are established by the State Board in *Policy for the Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SIP) (State Board 2000).

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protocols under which Regional Boards can consider and designate receiving water mixing zones and dilution credits in establishing NPDES effluent limits that implement the CTR receiving water standards.

3.3.3.3 Thermal Plan Requirements

The State of California Water Quality Control Plan for the Control of Temperature in Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan) was adopted by the State Board in 1971, and revised in 1972, and again in 1975.[3] The Thermal Plan establishes statewide standards governing allowable temperature in discharges to state waters. Key temperature control provisions for discharges to inland surface waters include:

- Thermal waste discharges having a maximum temperature greater than 2.8°C above the natural receiving water temperature are prohibited
- Elevated temperature wastes shall not cause the temperature of warm interstate waters to increase by more than 2.8°C above natural temperature at any time or place[4]

Limitations on temperature increases will be a consideration for SWA projects because the higher temperature of wastewater will result in a higher temperature advanced treated discharge.

3.3.3.4 Chlorine Residual Requirements

EPA has established national criteria[5] for chlorine residual concentrations to protect freshwater aquatic life, including:

- CMC (1-hour) value of 19 micrograms per liter (µg/L)
- CCC (4-day) value of 11 µg/L

Draft statewide chlorine standards currently being considered by the State Board would require that dischargers reduce chlorine residual in discharges to receiving waters to as close to zero as practicable.[6] Pending approval of statewide standards for chlorine residual, the State Board (2014) has implemented the EPA chlorine residual criteria in the current statewide NPDES permit governing discharges to surface waters from drinking water systems.[7] Because the criteria are lower than the sensitivity of many chlorine analyzers, non-detect values from a chlorine meter are typically sufficient to satisfy the chlorine residual requirements. If free chlorine disinfection is used as part of an SWA project, provisions will need to be provided for dechlorination prior to discharge to a reservoir.

3.3.3.5 Antidegradation Criteria

The State of California policy on antidegradation is set forth in State Board Resolution 68-16,[8] which establishes the following policy that requires maintenance of high-quality waters:

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[3] The 1975 version of the Thermal Plan was implemented through adoption of State Board Resolution 75-89.

[4] A temperature of 2.8°C corresponds to 5°F.

[5] U.S. Environmental Protection Agency (EPA). National Recommended Water Quality Criteria. Located online at the EPA website at: water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm. Updated 2014.

[6] State Water Resources Control Board (State Board). *Total Residual Chlorine and Chlorine-Produced Oxidants Policy of California*. 2006.

[7] State Water Resources Control Board (State Board). *Order WQ 2014-0194-DWQ, General Order CAG140001, Statewide National Pollutant Discharge Elimination System (NPDES) Permit for Drinking Water System Discharges to Waters of the United States*. 2014.

[8] Resolution 68-16, *Statement of Policy with Respect to Maintaining High Quality Waters in California* was adopted by the State Board on October 28, 1968. California's 1968 antidegradation policy predates the creation of the U.S. Environmental Protection Agency, the 1972 federal Clean Water Act, and the implementation of the federal NPDES permit program.

> *Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses of such water and will not result in water quality less than that prescribed in the policies.*

The State of California antidegradation policy (which preceded the 1972 Clean Water Act and federal antidegradation regulations) applies to all state waters, and requires that the existing water quality be maintained unless it is demonstrated that the benefits associated with the proposed water quality degradation outweigh the detriments. Any proposed SWA project will require an evaluation of the baseline water quality of the receiving reservoir and the potential for degradation due to SWA.

3.3.4 Permitting Baseline Approach

As with GWR, the most straightforward permitting approach is to offer the broadest balance of the public health elements that are contained within the regulation. In SWA, the main public health components include treatment and monitoring, dilution, and theoretical retention time. Projects can offset higher treatment and monitoring requirements by providing higher levels of dilution and theoretical retention time. The “baseline” approach would be to pursue a project that provided (1) 6 or more months of theoretical retention time, (2) minimum dilutions in excess of 100-to-1, and (3) treatment meeting the 8/7/8 pathogen log reductions for V/G/C. Under such conditions, no conditions would trigger additional regulatory hurdles (as would happen for retention times less than 4 months) or would require higher degrees of treatment (as would be needed for dilutions less than 100:1).

Given that San Diego’s SWA project is the only one currently permitted in California, the steps required to permit an SWA project—even under a baseline strategy—may be more involved than a GWR project, where the industry and regulators have more than 50 years of experience. Thus far, both projects pursuing SWA—the City of San Diego and the East County Advanced Water Purification program—have a number of commonalities that have contributed to their progress:

- Demonstration facilities used to develop water quality and performance data in accordance with DDW-approved test plans
- Engagement with IAPs and DDW
- Reservoir and hydrological modeling studies
- Tracer studies

All of these findings have been presented to regulatory bodies and have been critical in both their permitting efforts (e.g., Engineering Reports) and the design of the full-scale facilities. It is likely that projects that are pursued in the near future will also need similar levels of effort to support their permitting efforts.

Because only one SWA project has completed the permitting and design phase, there are much fewer precedents for the “baseline” SWA permitting approach compared to GWR. The City of San Diego’s project and the East County Advanced Water Purification program are both pursuing more aggressive projects, i.e., ones that trigger one or more clauses in the regulations that make these permitting approaches more involved. Box 3 describes the City of San Diego’s experience permitting an SWA project that provides the minimum levels of dilution (10-to-1) and theoretical retention time (2 months).

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Box 3
Alternative Permitting for Surface Water Augmentation in San Diego

San Diego's original concept for its SWA project was to augment the San Vicente Reservoir, a 247,000-acre-foot reservoir that would provide years of theoretical retention time for a 30-mgd project. Nevertheless, the reservoir is located approximately 25 miles northeast from the city of San Diego in a mountainous region in the eastern part of the county. While offering advantages in terms of both long theoretical retention times and high degrees of dilution, it would also incur expensive pipeline infrastructure traversing multiple jurisdictions. At the time the project was conceived, there were no draft SWA regulations. Over the course of the project, however, the California State Expert Panel began to provide input to DDW and the State Board about the shape of the future SWA regulations. As it became clearer that the regulations might allow for broader flexibility in reservoir operation, San Diego began to evaluate alternative options.

The alternative that it ultimately selected was the augmentation of Lake Miramar, a 6,000-acre-foot reservoir adjacent to the Miramar Water Treatment Plant, approximately 7 miles from the proposed advanced treatment facility at the North City Water Reclamation Plant. This option would (1) reduce the pipeline costs by more than 50 percent, (2) allow for faster project completion, (3) decrease complexity by involving only a single agency, and (4) lead to lower environmental impacts. The City concluded that these benefits outweighed the "costs" of pursuing a project with a less-certain permitting pathway. Based on the proposed project size (30 mgd) and the size of the reservoir, the project would be able to provide only 2 months of theoretical retention time at buildout. At the time of the project's conception, this short retention time option was not yet available in the regulation. For this reason, the City invested in efforts to demonstrate that the Miramar SWA project could be equally protective of public health.

The City determined that reducing certain protections—e.g., dilution and retention time—would require compensation by other elements. Accordingly, its 1-mgd demonstration FAT facility (Figure 3-9) was augmented to provide additional treatment barriers (ozone and biological activated carbon) to further guarantee the consistency of the high-quality water used to augment the reservoir. San Diego discussed this option with its IAP, presented the findings from its year-long study on the high performance of the system, and—based on these findings—received IAP support for an SWA project with a 2-month retention time. Through these interactions, DDW also provided input that helped the project team develop the data necessary to approve this approach. San Diego gained final approval for the State's first SWA permit in May 2020.

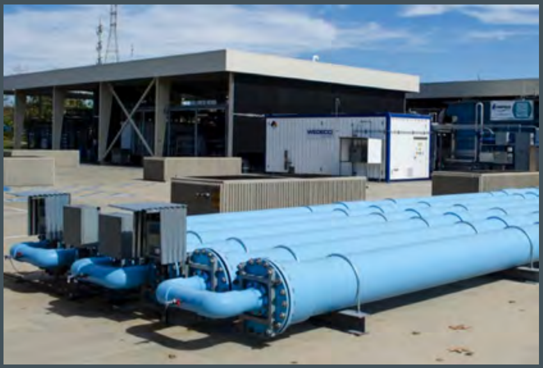

Figure 3-9. Demonstration pure water facility at San Diego's North City Water Reclamation Plant

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3.4 Direct Potable Reuse

This section describes DPR, including a regulatory summary and key considerations.

3.4.1 Regulatory Summary

In 2010, SB 918 required CDPH, now DDW, to investigate the feasibility of developing uniform water recycling criteria for DPR and to report its findings to the State Legislature by December 2016. In addition, SB 918 mandated that an expert panel be convened to advise DDW on scientific and technical matters regarding DPR feasibility. The expert panel released its final report in August 2016, concluding that it is feasible to develop uniform criteria for DPR. The panel suggested six research topics that should be investigated to further ensure the protectiveness of DPR, which are summarized in Figure 3-10.

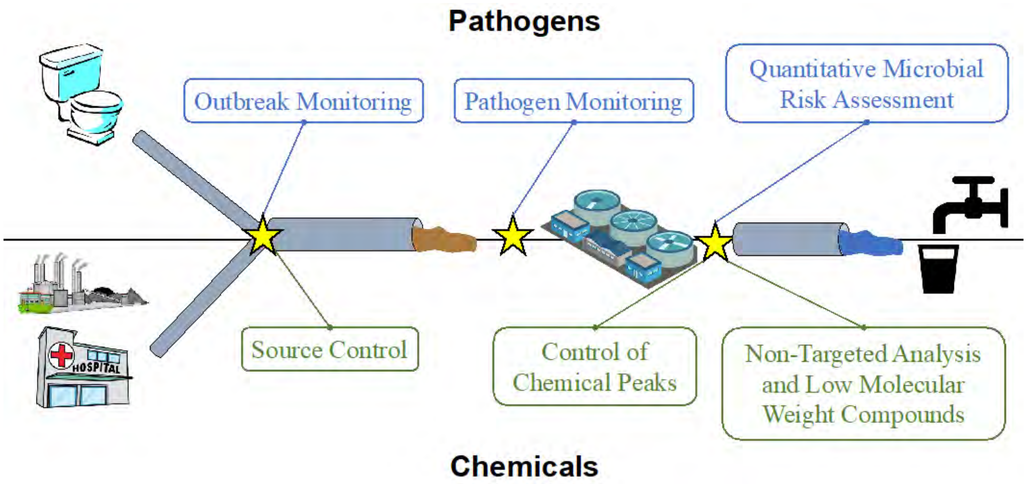
Pathogens
Outbreak Monitoring
Pathogen Monitoring
Quantitative Microbial Risk Assessment
HOSPITAL
Source Control
Control of Chemical Peaks
Non-Targeted Analysis and Low Molecular Weight Compounds
Chemicals

Figure 3-10. Six DPR research topics identified by the State expert panel

DDW delivered its final report to the State Legislature in December 2016, concluding that the six research topics must be addressed *before* uniform water recycling criteria can be developed.

Assembly Bill (AB) 574, which was signed into law in October 2017, requires that the State Board develop uniform water recycling criteria for RWA by 2023. It also mandated the development of a framework for the regulation of PR projects by June 2018; the draft framework was released by DDW on April 19, 2018 (Figure 3-11). It should be noted that AB 574 specifies that the State Board retains the right to permit PR projects pursuant to the Health and Safety Code before the adoption of uniform water recycling criteria. Although the State Board has the authority, it is not clear what requirements would be imposed for a DPR project seeking permitting prior to the development of uniform DPR regulations.

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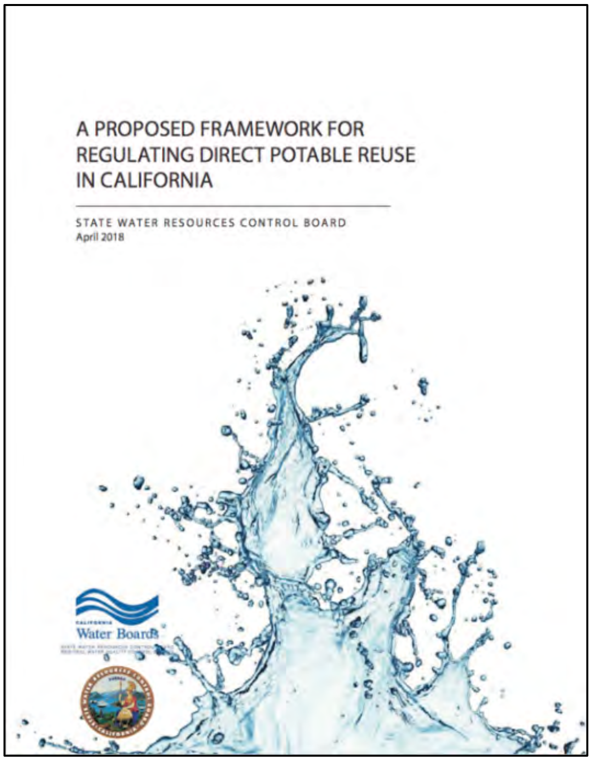

A PROPOSED FRAMEWORK FOR
REGULATING DIRECT POTABLE REUSE
IN CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD
April 2018

Figure 3-11. Framework for regulating DPR in California, released by the State Board's DDW in April 2018

3.4.2 Key Considerations

Permitting a DPR project at this early stage of the regulatory development process will be challenging. First and foremost, the regulators are waiting for the results of multiple parallel research efforts that are currently under way. In its report to the State Legislature, DDW stated that these knowledge gaps would need to be addressed before it could develop uniform criteria (State Board 2016). Furthermore, DDW understands the benefit of *experience* on the development of its previous regulations: GWR regulations evolved multiple times over the nearly 40-year period during which they were in draft form, with each iteration improving on the public health protections provided. While the SWA regulations were written without the benefit of an existing project, the regulators drew from the GWR experience to develop the SWA regulations. As the transition is made now from SWA to DPR, the regulators will leverage PR experience and research broadly, including outside of California, to help inform DPR regulations. Accordingly, DDW will likely prefer a cautious and deliberate approach to permit DPR projects before the regulations are developed.

While the exact requirements for DPR systems are not yet fleshed out, numerous documents provide indications of the elements that will be included. In its DPR Regulatory Framework document, DDW stated that “DPR regulations will need to include additional criteria to compensate for the loss of the protective benefits assured by the presence of a meaningful environmental buffer in IPR projects” (State Board 2018). Echoing this, the State expert panel suggested that the benefits of the environmental buffer could be substituted with enhanced reliability provided by mechanical systems and treatment performance (Olivieri et al. 2016). These include the following:

- Enhanced treatment
- Control of chemical contaminants

- Monitoring and control
- Source control
- Operator certification
- TMF capabilities

3.4.2.1 Enhanced Treatment

Both the State expert panel and the recent DPR Regulatory Framework document have indicated that DPR will require additional treatment beyond what has been specified for IPR scenarios (Olivieri et al. 2016; State Board 2018). While they have not provided specific requirements for the particular treatment train or trains needed, they have indicated that it will be an enhanced form of the FAT process. What enhancements are necessary have not been determined, though DDW offered that O3/BAC pretreatment may be an option (State Board 2018).

The rationale for the enhanced treatment is that it can help compensate for the lack of an environmental buffer. By requiring treatment redundancy, i.e., treatment beyond the minimum needed for public health protection, the system will reduce its probability of failing to meet the minimum targets. The consistency with which the train will be required to meet the risk-based health targets will likely increase. Requiring redundant treatment is a practical way of ensuring that the log removal value (LRV) targets are consistently met. Higher degrees of treatment will also need to be coupled with stricter O&M procedures and tighter control of the treatment barriers (i.e., critical control points) (State Board 2018).

Currently, the State Board is sponsoring three research projects that will impact the level of treatment ultimately required for DPR: one to look at performance evaluations and quantitative microbiological risk assessment (QMRA), one to evaluate the concentration of pathogens that might be present in the raw sewage source water, and a study to understand how disease outbreaks might impact those numbers. The findings from these studies will help to inform the future minimum criteria for enhanced DPR treatment.

3.4.2.2 Control of Chemicals

The general framework for controlling chemicals in PR follows three steps: (1) identify chemicals of concern, (2) set up treatment and monitoring to evaluate a suite of relevant chemicals, and (3) specify performance criteria to reduce these chemicals below levels of health concern. This approach is further supported by source control, which aims to limit the discharge of these compounds into the wastewater. In IPR settings, the environmental buffer provides *time* to take samples and evaluate results prior to distributing the water; in DPR this will not be an option. Consequently, the regulatory structure will need to adapt to focus more on the use of surrogates/indicators that can be measured on a continuous basis, in tandem with additional treatment that improves the reliability and robustness of the treatment train (Figure 3-12).

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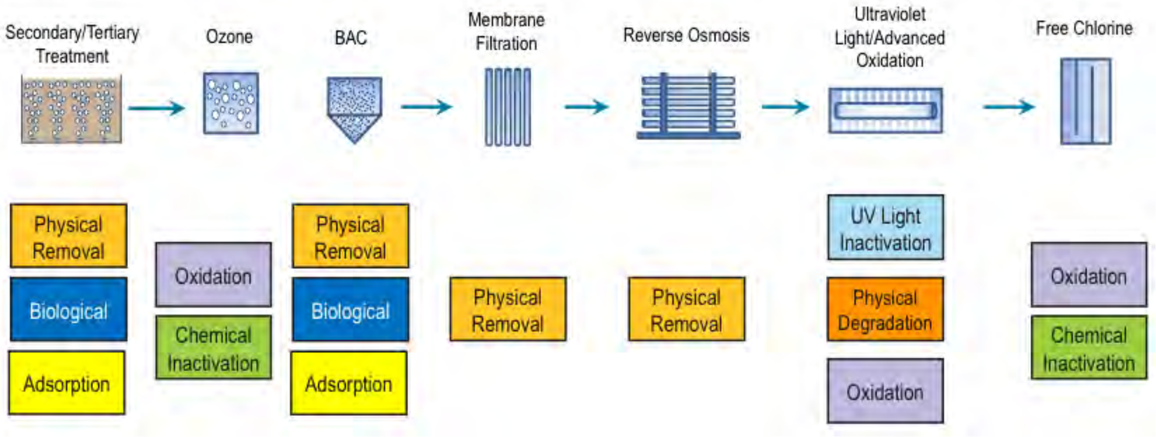

Figure 3-12. Diversity of removal mechanisms provides a high degree of control for chemicals and mitigates unknown chemical contaminants

One group of chemical constituents that is of greater importance in DPR settings are those that have been shown to pass through FAT trains—namely, the low molecular weight organic compounds. Several strategies have been proposed to deal with these compounds, including:

- Enhanced source control
- Provision of additional treatment barriers at the AWTF
- High-frequency monitoring of TOC (or other surrogate[s] for organic compounds) in final effluents

Another future requirement may be the optimization of the WWTP (State Board 2018). In line with the expert panel's treatment recommendations, providing a high degree of treatment at the WWTP—including biological nutrient removal with filtration—further ensures a high-quality, stable source water to feed the AWTF. Future DPR requirements may stipulate the degree of wastewater treatment preceding the AWTF for this reason.

The combination of these efforts—source control, enhanced wastewater and advanced treatment, and continuous monitoring—will help prevent, detect, and respond to any peaks of chemicals that may make their way to and through the WWTP.

3.4.2.3 Monitoring and Control

As the time and distance between the treatment process and consumer grows smaller, it becomes increasingly important to continuously track the status of the treatment processes and purified water quality. If treatment fails, urgent action is required and the only way to respond quickly is to provide a high degree of monitoring and control. The stringency of monitoring will be higher than what is currently required for IPR for both pathogens and chemicals (State Board 2018). DDW has also highlighted the future use of advanced chemical detection techniques, including non-targeted analysis and bioassays.

3.4.2.4 Source Control

As noted above, source control programs will likely be more stringent than those used for existing IPR systems. Per the expert panel report, source control is a priority research topic and the State Board has allocated funds for a future IAP to outline the components and scope of the enhanced source control programs. This ongoing research should provide findings in the next 18 to 24 months.

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3.4.2.5 Operator Certification

The water industry has understood the important role that operations will have in the future success of DPR systems. Given the high reliance on engineered systems for public health protection, DPR systems will need operators with a high degree of advanced treatment training. Both the California Water Environment Association (CWEA) and the California-Nevada Section of the American Water Works Association (CA-NV AWWA) joined together to develop and jointly administer a voluntary Advanced Water Treatment Operator (AWTO) certification that includes three different grade levels.

3.4.2.6 Technical, Managerial, and Financial Capacity

The IPR regulations have requirements for the TMF capacity of the project sponsors. DDW has stated that the threshold for TMF capacity will increase as the movement is made from IPR to DPR, since the complexity and sophistication of DPR systems is higher. DPR will typically require a greater number and diversity of treatment processes, more stringent monitoring requirements, and critical control points.

3.4.2.7 Phasing

DDW has emphasized that it would like to progress toward TWA—the most direct form of DPR—in a methodical and phased approach (State Board 2018). Phasing from an IPR project (GWR or SWA) into RWA will have numerous benefits. By starting with GWR/SWA, DDW has a chance to evaluate the capacity of an agency to comply with the IPR regulations, which are strict but not as rigorous as the future DPR regulations. This period also puts lower stakes on the engineered aspects of public health protection because these systems will necessarily be complemented by an environmental buffer. Because a higher degree of rigor will be required for DPR (in terms of treatment, monitoring, control, and operations), having an initial period with IPR may provide an easier pathway to permitting. DDW has stated that it wants to "walk before it runs," meaning that it would like to move progressively from IPR to RWA and then again slowly from RWA to TWA.

Timing will be a key consideration for the permitting of an RWA project. Per AB 574, DDW anticipates developing uniform regulations by the end of 2023, with the possibility of extending this deadline for 1 year. A phased project that begins with IPR and transitions into RWA could anticipate a high degree of regulatory clarity in the 2023 to 2024 time frame. Agencies looking to pursue TWA might anticipate final regulations 5 years after the development of RWA regulations (e.g., 2028 to 2029).

Section 4: Residuals Management

PR projects can produce significant volumes of residuals. The previous sections have discussed environmental criteria for discharge of treated effluent to end uses (e.g., landscape irrigation for NPR) and environmental buffers (e.g., aquifer discharge for groundwater recharge). This section focuses specifically on the management of residual streams generated by reuse treatment and their potential regulatory requirements.

Most PR applications within California use FAT, which includes low-pressure MF followed by RO and UV-AOP. The low-pressure filtration process produces a relatively small residual flow of backwash water, which can either be discharged via sewer or recycled to the WWTP headworks (Section 4.3). Low-pressure membrane and occasional UV-AOP chemical cleaning produce small volumes of cleaning waste chemicals, which are also discussed in Section 4.3. The largest residual volume produced in an RO-based PR system is RO concentrate, disposal of which is discussed in Section 4.2.

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4.1 NPDES Permits

A common strategy for residuals management is to discharge these streams through surface water outfalls, either alone or in combination with existing effluent discharges. In this case, these discharges would be addressed through NPDES permits, which are issued by the Regional Board (either Region 2 – SFB or Region 3 – CC). NPDES permits for discharges to surface waters contain specific requirements that limit the pollutants in discharge effluent. Some pollutant limits are load-based (e.g., pounds per month), but most are concentration-based (e.g., mg/L of TDS). This is a critical consideration for residuals, especially RO concentrate, as they are highly concentrated waste streams that may strain existing NPDES concentration limits if added to the existing discharge stream. NPDES permits also require screening tests for chronic toxicity (a detrimental biological effect on the health of an organism population or community), and in some cases, may also limit daily effluent flow (e.g., SCRWA WWTP). These limitations in effluent flow serve as a strategy to mitigate contaminant discharges into a water body that may be close to or exceeding its beneficial use water quality standards.

There are two types of NPDES permits: General and Individual. The General Permit is intended to cover multiple facilities within a specific category. For example, the SFB Regional Board has a Groundwater General Permit for the *Discharge or Reuse of Extracted Brackish Groundwater, Reverse Osmosis Concentrate Resulting from Treated Brackish Groundwater, and Extracted Groundwater from Structural Dewatering Requiring Treatment* (Order R2-2012-0060), which regulates general waste discharge requirements within those conditions. The full list of General NPDES wastewater permits for California can be found on the State Board website.

The Individual Permit is a permit tailored to a specific facility that is issued by a Regional Board for an effective period not to exceed 5 years. It is anticipated that any WWTP that may receive residuals from PR (e.g., San José/Santa Clara RWF or the Sunnyvale WPCP) would have an individual permit. In instances where RO concentrate is being discharged to a surface water, there may also be a need for a separate NPDES permit (discussed further in Section 4.2).

Discharge of residuals from recycled water projects may require either a new NPDES Individual Permit or modification of an existing NPDES permit. Residuals that are being discharged into an existing sewer system (e.g., RO concentrate) may also require an industrial discharge permit from the municipality that manages that sewer system. If residual streams are routed to existing outfalls, a careful review of potential impacts to existing NPDES permits will be needed to identify whether all effluent discharge water quality requirements will still be met with the new project, or if permit modifications and/or further waste stream treatment is needed. Some issues of concern, particularly in RO concentrate, are TDS, nutrients, metals, and toxicity.

4.1.1 Existing NPDES Permits

Four WWTPs in Santa Clara County have existing NPDES permits: San José/Santa Clara RWF, Sunnyvale WPCP, Palo Alto RWQCP, and SCRWA WWTP. If residuals are to be discharged into the sanitary sewer system upstream of these facilities, the potential impacts to these WWTPs must be considered. The existing NPDES permits for each of these facilities are summarized below.

The NPDES permit limits shown below are set to meet a variety of effluent requirements from various state and federal laws, including the Basin Plan and the National Toxics Rule. Change in discharge from any of these WWTPs (e.g., an increase in TDS and metals from RO concentrate) could impact a WWTP's ability to continue meeting its NPDES permit limits.

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4.1.1.1 San José/Santa Clara Regional Wastewater Facility

San José/Santa Clara RWF serves 1.4 million residents in the San José and Santa Clara region. It treats an average of 110 mgd of wastewater, with a capacity of up to 167 mgd, and discharges advanced secondary-treated effluent to the Artesian Slough, which is a tributary to the South SF Bay via Coyote Creek. Its existing NPDES permit is SFB Regional Board Order R2-2014-0034/NPDES Permit CA0037842, and the effluent limits are summarized in Table 4-1.

Table 4-1. Effluent Limits for San José/Santa Clara RWF

Parameter	Unit	Effluent Limitations				
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
5-day carbonaceous biochemical oxygen demand ($CBOD_5$) at 20°C	mg/L	10	---	20	---	---
Total suspended solids (TSS)	mg/L	10	---	20	---	---
Oil and grease	mg/L	5	---	10	---	---
pH	Standard units	---	---	---	6.5	8.5
Total residual chlorine	mg/L	---	---	---	---	0.0
Turbidity	NTU	---	---	---	---	10
Total ammonia, as N	mg/L	3.0	---	8.0	---	---
Copper, total recoverable	µg/L	11	---	19	---	---
Nickel, total recoverable	µg/L	25	---	33	---	---
Cyanide, total	µg/L	5.7	---	13	---	---
Indeno (1,2,3-cd) pyrene	µg/L	0.049	---	0.098	---	---
Dioxin-TEQ	µg/L	1.4×10^{-8}	---	2.8×10^{-8}	---	---

Source: SFB Regional Board NPDES Permit CA0037842 (effective 11/1/2014).

In addition to these numeric limits, the San José/Santa Clara RWF has a narrative limit for chronic toxicity, such that the effluent does not cause or contribute to toxicity in the receiving water, Routine chronic toxicity testing is conducted monthly using *Ceriodaphnia dubia* as the test species.

Typically, discharge into shallow waters or dead-end sloughs is prohibited; however, the San José/Santa Clara RWF has an exception. Because the receiving water is shallow and supports biologically sensitive habitats, the plant has no dilution credit for most parameters; however, the plant does have a dilution credit for cyanide (3:1 ratio).

4.1.1.2 Sunnyvale Water Pollution Control Plant

The Sunnyvale WPCP treats an average flow of 11.9 mgd and discharges advanced secondary-treated effluent to the Moffett Channel, which is a tributary to the South SF Bay via the Guadalupe Slough. Effluent limits are set by SFB Regional Board Order R2-2014-0035/NPDES Permit CA0037621 and summarized in Table 4-2.

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Table 4-2. Effluent Limitations for Sunnyvale WPCP						
		Effluent Limitations				
Parameter	Unit	Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
$CBOD_5$ at 20°C	mg/L	10	---	20	---	---
TSS	mg/L	20	---	30	---	---
Oil and grease	mg/L	5	---	10	---	---
pH	Standard units	---	---	---	6.5	8.5
Total residual chlorine	mg/L	---	---	---	---	0.0
Turbidity	NTU	---	---	---	---	10
Total ammonia, as N (October–May)	mg/L	18	---	26	---	---
Total ammonia, as N (June–September)	mg/L	2	---	5	---	---
Copper, total recoverable	µg/L	10	---	19	---	---
Nickel, total recoverable	µg/L	24	---	35	---	---
Cyanide, total	µg/L	7.5	---	17	---	---
Dioxin-TEQ (TEQ = toxicity equivalency)	µg/L	1.4×10^{-8}	---	2.8×10^{-8}	---	---
Bis (2-ethylhenxyl) phthalate	µg/L	5.9	---	12	---	---

Source: SFB Regional Board NPDES Permit CA0037621 (effective 11/1/2014).

In addition to these numeric limits, the Sunnyvale WPCP has a narrative limit for chronic toxicity, such that the effluent does not cause or contribute to toxicity in the receiving water, Routine chronic toxicity testing is conducted monthly using *Thalassiosira pseudonana* as the test species.

Sunnyvale WPCP also has an exception that allows discharge to shallow water. Because the receiving water is a shallow, tidal slough with limited upstream freshwater flows, the plant has no dilution credit for most parameters; however, the plant does have a dilution credit for cyanide (4:1 ratio).

4.1.1.3 Palo Alto Regional Water Quality Control Plant

The Palo Alto RWQCP treats 20 mgd of wastewater for six communities: Palo Alto, East Palo Alto, Mountain View, Stanford, Los Altos, and Los Altos Hills. Its effluent is regulated by SFB Regional Board Order R2-2014-0024/NPDES Permit CA0037834, which is summarized in Table 4-3. It discharges secondary-treated effluent into two different discharge points (with the same effluent limits described in Table 4-3)—the first is directly into the South SF Bay, and the second is into Matadero Creek.

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Table 4-3. Effluent Limitations for Palo Alto RWQCP

Parameter	Unit	Effluent Limitations Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
$CBOD_5$ at 20°C	mg/L	10	---	20	---	---
TSS	mg/L	10	---	20	---	---
Oil and grease	mg/L	5	---	10	---	---
pH	Standard units	---	---	---	6.5	8.5
Total residual chlorine	mg/L	---	---	---	---	0.0
Turbidity	NTU	---	---	---	---	10
Total ammonia, as N	mg/L	2.7	---	9.5	---	---
Copper, total recoverable	µg/L	21	---	36	---	---
Nickel, total recoverable	µg/L	26	---	31	---	---
Cyanide, total	µg/L	6.2	---	14	---	---
Dioxin-TEQ	µg/L	1.4×10^{-8}	---	2.8×10^{-8}	---	---

Source: SFB Regional Board NPDES Permit CA0037834 (effective 8/1/2014).

In addition to these numeric limits, the Palo Alto RWQCP has a narrative limit for chronic toxicity, such that the effluent does not cause or contribute to toxicity in the receiving water, Routine chronic toxicity testing is conducted monthly using *Pimephales promelas* as the test species.

Palo Alto RWQCP also has an exception that allows discharge to shallow water; Palo Alto's water reuse projects and maintenance of Renzel Marsh help to justify this exception. Furthermore, Palo Alto has dilution credits for cyanide (3.25:1 ratio) and copper (3.5:1 ratio) at both discharge points.

4.1.1.4 South County Regional Wastewater Authority Wastewater Treatment Plant

SCRWA is a joint powers authority established to manage wastewater treatment for the cities of Gilroy and Morgan Hill. SCRWA manages the SCRWA WWTP, which is designed to treat up to 8.5 mgd for dry weather secondary treatment standards and 9.0 mgd for tertiary filtered and disinfected standards. Effluent limitations are regulated by Central Coast Regional Water Quality Control Board (CC Regional Board) Order R3-2017-0028/NPDES Permit CA0049964.

SCRWA's NPDES permit describes three discharge locations, with differing effluent limitations for each. Discharge Point 001 is land application of treated secondary effluent to percolation ponds that are adjacent to Llagas Creek, Discharge Point 002 is disinfected tertiary recycled water to the Pajaro River, and Discharge Point 003 is also disinfected tertiary recycled water for reclamation use. The effluent limitations for Discharge Points 001 and 002 are listed below in Table 4-4 and 4-5, respectively. The effluent for Discharge Point 003 (recycled water for reclamation) must meet the water quality requirements for disinfected tertiary recycled water as described in Section 2 (NPR).

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Table 4-4. Effluent Limitations for SCRWA's Discharge Point 001					
		Effluent Limitations			
Parameter	Unit	Average Monthly	Average Weekly	Maximum Daily	12-Month Moving Average
5-day biochemical oxygen demand (BOD_5) at 20°C	mg/L	30	45	--	---
TSS	mg/L	30	45	---	---
Nitrate (as N)	mg/L	5	---	10	---
TDS	mg/L	---	---	---	900
Sodium	mg/L	---	---	---	175
Chloride	mg/L	---	---	---	200
Sulfate	mg/L	---	---	---	150
Boron	mg/L	---	---	---	1.0
pH	Standard units	6.5–8.3 at all times			

Source: CC Regional Board NPDES Permit CA0049964 (effective 12/1/2017).

Table 4-5. Effluent Limitations for SCRWA's Discharge Point 002				
Parameter	Unit	Effluent Limitations		
		Average Monthly	Average Weekly	Maximum Daily
Flow	MGD	---	---	9.0
BOD5 at 20°C	mg/L	10	---	20
TSS	mg/L	10	---	20
Nitrate (as N)	mg/L	5	---	10
Un-ionized ammonia (as N)	mg/L	0.025	---	0.050
pH	Standard units	7.0–8.3 at all times		
TDS	mg/L	1,000	---	---
Sodium	mg/L	200	---	---
Chloride	mg/L	250	---	---
Sulfate	mg/L	250	---	---
Boron	mg/L	1.0	---	---
Chlorine, total residual	mg/L	---	---	a
Chlorine, total residual	mg/L	---	---	a
Copper, total recoverable	µg/L	20	---	42
Lead, total recoverable	µg/L	2.1	---	4.2
Chlorodibromomethane	µg/L	0.40	---	0.80
Dichlorobromomethane	µg/L	0.45	---	0.90
Trihalomethanes, total	µg/L	80	---	160

a. *Chlorine concentrations shall at no time exceed detection levels as determined by amperometric titration or other equally sensitive method.*

Source: NPDES Permit CA0049964 (effective 12/1/2017).

Regulated by the CC Regional Board, SCRWA has different chronic toxicity testing requirements than the other three plants. Routine monitoring is conducted once per year using the water flea, *Ceriodaphnia dubia*, (survival and reproduction test); fathead minnow, *Pimephales promelas* (larval survival and growth test); and

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green alga, *Selanastrum capricornutum* (growth test), as test species. If chronic toxicity is detected in the effluent, SCRWA must resample immediately and report the results to the Executive Officer, who will determine whether to initiate an enforcement action, require a Toxicity Reduction Evaluation, or implement other measures.

Unlike the SF Bay plants, SCRWA receives no dilution credit.

4.1.2 Basin Plans

Key drivers for NPDES permits are the SFB Basin Plan and CC Basin Plan. Each of the surface water and groundwater bodies within the SFB and CC Basins has beneficial use designations and establishes the water quality attainment strategies, including total maximum daily loads (TMDL) as required by the Clean Water Act. TMDLs addressed by the Basin Plans include diazinon and pesticide-related toxicity, copper, mercury, selenium, various bacteria, various pathogens, PCBs, and sediment. There are also region-wide and area-specific TMDLs, and NPDES permit limits calculated to support compliance with the Basin Plans.

The pertinent water bodies to Santa Clara County include the Artesian Slough (San José/Santa Clara RWF), the Moffett Channel (Sunnyvale WPCP), the South SF Bay and Matadero Creek (Palo Alto RWQCP), and the Pajaro River (SCRWA WWTP). Each of these water bodies has beneficial use designations (Table 4-6), and associated water quality standards.

Table 4-6. Beneficial Uses of Relevant Water Bodies in Santa Clara County

	San José/Santa Clara RWF	Sunnyvale WPCP	Palo Alto RWQCP		SCRWA WWTP
Beneficial Use(s)	**Artesian Slough[a]**	**Moffett Channel[a]**	**South SF Bay[a]**	**Matadero Creek[a]**	**Pajaro River[b]**
Agricultural supply (AGR)					✓
Cold freshwater habitat (COLD)				✓	✓
Commercial and sport fishing (COMM)			✓		✓
Contact recreation (REC-1)	✓	✓	✓	✓	✓
Estuarine habitat (EST)	✓	✓	✓		
Fish migration (MIGR)			✓	✓	✓
Fish spawning (SPWN)			✓	✓	✓
Freshwater replenishment (FRSH)					✓
Groundwater recharge (GWR)					✓
Industrial process supply (PROC)					
Industrial service supply (IND)			✓		✓
Municipal and domestic supply (MUN)					✓
Navigation (NAV)			✓		
Non-contact water recreation (REC-2)	✓	✓	✓	✓	✓
Preservation of rare and endangered species (RARE)	✓		✓	✓	
Shellfish harvesting (SHELL)			✓		
Warm freshwater habitat (WARM)				✓	✓
Wildlife habitat (WILD)	✓	✓	✓	✓	✓

a. Source: SFB Basin Plan, Table 2-1.
b. Source: CC Basin Plan, Table 2-1.

While water quality limits that are set in the Basin Plan may not directly transfer to NPDES permits, effluent requirements are calculated with the intention of meeting water quality goals set in the Basin Plan. Future recycled water projects that may impact existing NPDES permits (as detailed above) must take those impacts into consideration during development of the project. Increases in constituent concentrations through the discharge of residuals or the diversion of water for reclamation may impact the WWTPs' abilities to meet their existing NPDES permit limits.

4.1.3 Waste Discharge Requirements for Nutrients to San Francisco Bay

Nutrients, such as nitrogen and phosphorus, are also regulated through the NPDES program. While there are currently no numerical limits for nutrients (except for ammonia) within each facility-specific NPDES permit, all WWTPs that discharge into the SF Bay are regulated by Order R2-2019-0017/NPDES Permit CA0038873, titled *Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay.* This region-wide permit sets monitoring and reporting requirements, as well as a mandate to evaluate potential nutrient discharge reduction through treatment optimization, sidestream treatment, or WWTP upgrades.

Whether a nutrient limit will be set in future permit revisions, and what it might be if it is, is still unknown. The limit could be either loading- or concentration-based, or both. For WWTPs that are looking to do water reuse, a concentration-based limit may be challenging to meet, as dilution flow is diverted for water reuse, thereby increasing nutrient concentrations. This would be exacerbated if RO concentrate is also part of that effluent flow.

For projects considering RO, management of the RO concentrate is a critical consideration in the conversation around nutrients. Concentrate streams have high concentrations of nutrients that will make meeting future nutrient limits challenging. A solution to managing RO concentrate streams could be to discharge it into a treatment cell, which will reduce nutrient concentrations before discharging through an outfall. Other management strategies to reduce nutrient loading to the SF Bay could be those that discharge the concentrate elsewhere, like injection or evaporation ponds. The future of effluent limits for nutrients is still unknown, but must be taken into consideration with the development of any new water reuse project.

4.2 RO Concentrate Management

For projects that use RO, management of the RO concentrate stream is an important part of the permitting process. RO concentrate is the waste stream from an RO system, which treats water by using high-pressure pumps to push water through a semipermeable membrane. This membrane removes dissolved salts (TDS), particles, colloids, organic matter, and microorganisms from the feed water. The treated water (permeate) is sent to the next treatment process, while the waste stream (concentrate) is sent to a concentrate management system.

As an RO system rejects 95 to 99 percent of dissolved salts, this concentrate stream contains high levels of TDS that must be properly managed. There are various strategies for RO concentrate management. These strategies are currently being studied by the District, and a plan is currently being developed that will be incorporated into the Master Plan process as information becomes available. The strategies under consideration include sanitary sewer discharge, discharge into an existing or new outfall, treatment cells, evaporation ponds, and deep-well injection.

4.2.1 Sanitary Sewer Discharge

One strategy for RO concentrate management is discharge into an existing sanitary sewer system for treatment at a WWTP. This would require coordination with the managing utility, which may include acquiring an industrial discharge permit. Multiple costs are associated with this strategy, including those of a new

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sanitary sewer/treatment plant connection and the potential increase in unit treatment costs due to increased 5-day BOD_5 and TSS concentrations of the wastewater influent.

Potential downstream impacts to the collection system or WWTP should also be considered. High sulfate or chloride levels, i.e., >1,000 mg/L (Rimer et al. 2006) could cause corrosion within the pipeline, and RO concentrate may need to be discharged in locations where there is sufficient flow to provide dilution. Pollutant increases could also impact downstream WWTP operations, particularly increases in nutrients and trace metals. They could strain existing WWTP operations, impacting biological processes such as nitrification (Sawyer et al. 2016). These increases in concentrations in WWTP influent can also translate to increased concentrations in the effluent, which could challenge NPDES permit limits (e.g., by contributing to toxicity in the receiving water) or impact downstream advanced water treatment facilities. For example, increases in TDS could impact downstream potable RO systems and create a positive feedback loop.

4.2.2 Discharge Through an Outfall

Another strategy for RO concentrate management is discharge through an existing or new outfall. The benefit of this strategy is that it avoids impacts on downstream collection systems and WWTP processes. However, the viability of this strategy depends on the impact of the concentrate flow on pollutant concentrations or toxicity limits specified in an existing outfall's NPDES permit. Anticipated water quality concerns for RO concentrate disposal through existing outfalls include nutrients, TOC, TDS, and trace metals like copper and nickel. Metals are of particular concern because they typically have concentration-based limits. As wastewater effluents are diverted for water reuse, the available dilution volume to reduce the concentrations of these contaminants goes down, making NPDES compliance potentially challenging.

Construction of a new outfall could be a regional concentrate disposal solution. However, similar to using an existing outfall, it would require obtaining an NPDES permit and ensuring compliance with the Basin Plan. This strategy was examined in the *South Bay Water Recycling Strategic and Master Plan* (2014), and a location was identified in the South SF Bay that could provide a 10:1 dilution. This solution would not increase TDS concentrations within the existing sewer system, but would require the construction of a new pump station and pipeline.

4.2.3 Engineered Wetlands and Treatment Cells

RO concentrate could be managed and treated through engineered wetlands. A potential option for these wetlands is the South Bay Salt Pond Restoration Project (SBSPRP). Through a study by the City of Oxnard, it was demonstrated that engineered fresh and brackish water wetlands could reduce the concentrations of nutrients and trace contaminants in RO concentrate. Plants growing in the engineered wetlands reduced concentrations of dissolved organic carbon, nitrogen, ammonia, phosphorus, and trace metals through natural biological activity and adsorption (CH2M Hill 2007). If wetlands are designated as "treatment" wetlands, they would be permitted as part of the overall wastewater treatment process.

If necessary, additional pretreatment of open water treatment cells could be applied to further reduce pollutant loading. However, permitting for treatment cells could be challenging, as there would need to be coordination with the U.S. Army Corps of Engineers, Regional Board, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife, and the SF Bay Conservation and Development Commission.

Treated RO concentrate from treatment cells and engineered wetlands would have to be conveyed to another location for ultimate disposal; however, this management strategy could potentially be combined with another disposal option—e.g., the RO concentrate could be treated via engineered wetland before being discharged through a Bay outfall. The wetland would reduce RO concentrate pollutant concentrations and toxicity, potentially maintaining effluent concentrations below the NPDES permit limits.

Another approach is to leverage engineered wetlands for natural tidal wetlands restoration, and use the natural tides to flush the RO concentrate. However, the natural TDS concentrations for RO concentrate may not be high enough and may have to be increased to develop a natural saltwater marsh (RMC and CDM Smith 2014). Discharging treated effluent from an engineered wetland to natural wetlands would also require a new NPDES permit.

4.2.4 Evaporation Ponds

Another strategy is evaporation ponds, either with or without mechanical enhancement. The advantages of evaporation ponds include simple operation and the diversion of RO concentrate from the SF Bay. However, evaporation ponds require large areas of land, which is challenging in the highly urban areas around South SF Bay. The *South Bay Water Recycling Strategic and Master Plan* calculated that land requirements would be about 1,400 acres per 1 mgd of RO concentrate without mechanical enhancement and 500 acres per 1 mgd with mechanical enhancement (RMC and CDM Smith 2014). For permitting requirements, the development of an evaporation pond would be included in the application of an NPDES permit or WDR permit. Any existing NPDES or WDR permits would be subject to revision and re-approval by the Regional Board.

4.2.5 Deep-Well Injection

Deep-well injection is another management strategy that would divert RO concentrate from the SF Bay. The concentrate would be injected into a deep confined aquifer under pressure, and the injection zone would be selected to prevent impacts to any drinking water aquifers (or any other beneficial uses). This option is viable only in areas where the hydrogeological conditions are favorable, and no suitable aquifers have been readily identified in the South SF Bay area to date. For permitting, the State of California has primacy for Class II – oil and gas related wells; all other injection wells are regulated by the EPA and must be registered through the federal Underground Injection Control program.

4.3 Backwash Streams

The strategy chosen for managing the backwash streams generated by PR treatment can impact pathogen reduction credit. Typically, backwash streams (e.g., from MF backwashing) are either recycled to the WWTP headworks or discharged to the sewer. However, additional drivers may be present to deal with backwash streams in a different way. For example, at the Leo J. Vander Lans Water Treatment Facility, limitations on sewer discharge resulted in implementation of a secondary MF to increase the overall MF recovery. This setup resulted in a reduction of protozoa removal credit through the MF system. In addition, in the context of drinking water treatment, the *Cryptosporidium Action Plan* limits both the quality and quantity of backwash water that can be recycled to the headworks of a drinking water treatment plant. This type of restriction may be placed on AWTFs recycling their backwash streams to the WWTP headworks. These considerations should be taken into account when designing NPR and PR treatment trains.

4.4 NEPA/CEQA Implications

As projects seek funding via grants or loans from the State Board through the State Revolving Fund (SRF) Loan Program, Proposition 1 funds, or under Title XVI under the U.S. Bureau of Reclamation, compliance with the environmental requirements under NEPA (federal) and CEQA (state) may be required. There are opportunities to do a combined NEPA/CEQA document to streamline schedule and permitting.

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4.4.1 NEPA Requirements

Compliance with NEPA is required if pursuing Title XVI funding. NEPA requires federal agencies to assess the environmental, social, and economic effects of any proposed actions. A NEPA Environmental Assessment (EA) should address NEPA requirements, including the following:

- **Federal Endangered Species Act**: A Biological Assessment (BA) Report will need to be prepared for the State Board for use to confer informally with USFWS and/or the National Marine Fisheries Service about potential impacts of federally listed species due to the construction and operation of the project. The BA will address species listed under the federal Endangered Species Act (ESA) that could be within the project area and the likelihood of the project adversely affecting those resources.
- **Federal General Conformity Rule for the federal Clean Air Act:** An analysis will need to be done to determine if a project's emissions and greenhouse gases are in general conformity with the federal Clean Air Act. The determination of conformity is a two-step process consisting of (1) applicability analysis and (2) conformity analysis. The applicant will conduct the analysis by comparing the project's emissions to the minimum pollutant thresholds outlined in the conformity rule.
- **National Historic Preservation Act:** A Cultural Resources Inventory Report will need to be prepared to comply with Section 106 of the National Historic Preservation Act of 1966. The criteria for determining the significance of impacts to cultural resources is the significance of the cultural resources themselves, as defined by the National Register Criteria (Code of Federal Regulations [CFR] Title 36 Part 60.4). This study will consist of an archaeological inventory of cultural surveys and archaeological reports, contacts with Native Americans, as well as a cursory reconnaissance survey of the proposed project area.
- **Socioeconomics**: Any adverse socioeconomic effects, Indian Trust Assets (property rights held in trust by the U.S. government), and any effects on low-income populations (per Environmental Justice Executive Order 12898) must be identified.

4.4.2 CEQA Requirements

CEQA provides the basis to protect environmental quality in the state of California. CEQA requires State and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. All public agencies must comply with CEQA when they undertake an activity defined as a "project." A project is an activity undertaken by a public agency or private activity that must receive an approval from a government agency that "has a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect change in the environment" (CCR, Section 15378).

Most proposals for physical development in California are subject to the provisions of CEQA, including actions involving the discharge of highly treated wastewater for recycled water applications or discharge of residuals. Every development project that requires discretionary governmental approval will require at least some environmental review pursuant to CEQA, unless an exemption applies. At a minimum, an initial review of the project and its environmental effects must be conducted. Depending on the potential effects, a further, and more substantial, review may be conducted in the form of an environmental impact report (EIR).

The review process to meet CEQA requirements should begin as soon as the recommended project elements are defined, as the process can be lengthy. Guidelines for the implementation of the CEQA process are included in CCR, Title 14, Section 3, and are also summarized in Figure 4-1.

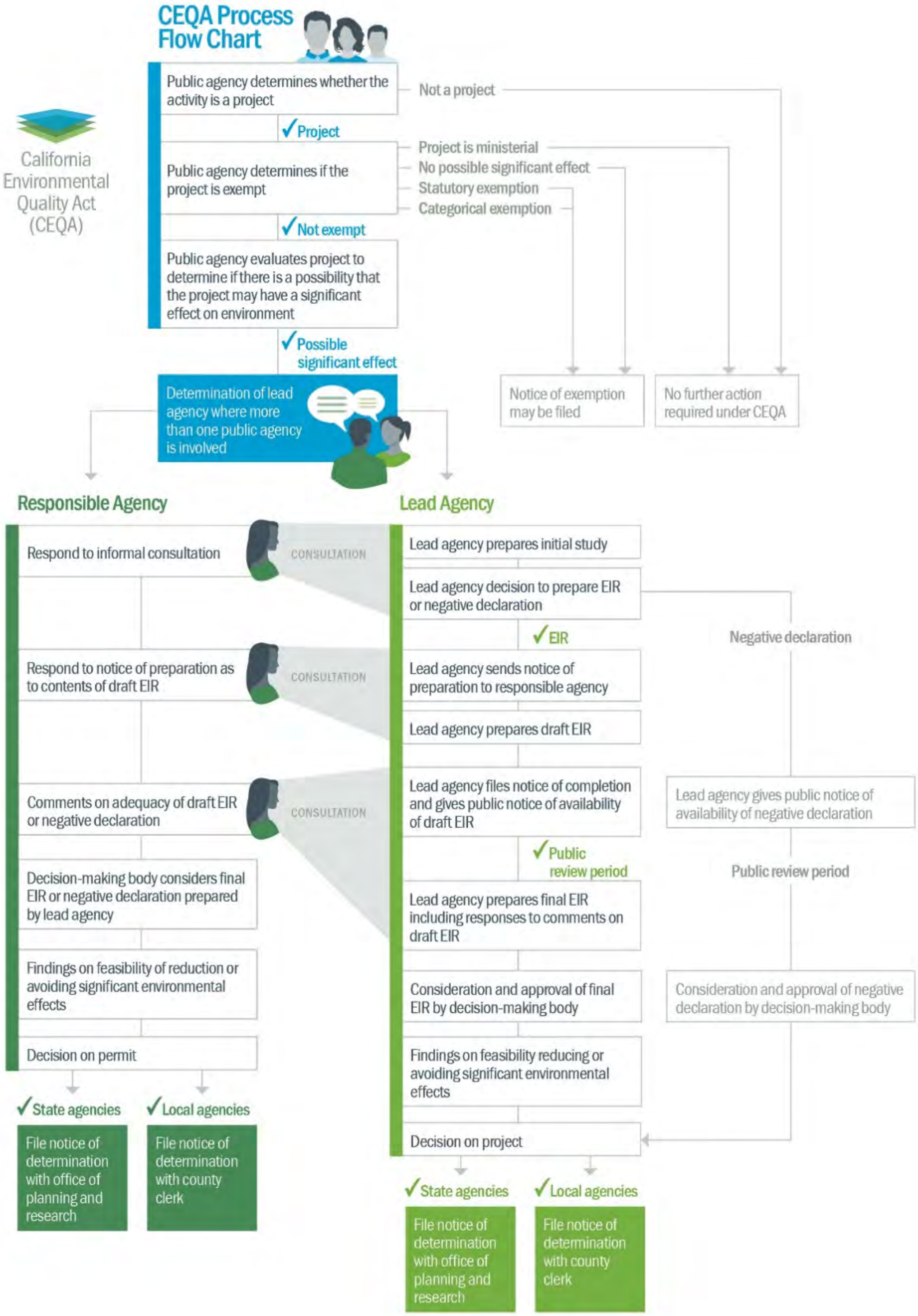
CEQA Process Flow Chart
California Environmental Quality Act (CEQA)
Public agency determines whether the activity is a project
Not a project
✓Project
Public agency determines if the project is exempt
Project is ministerial
No possible significant effect
Statutory exemption
Categorical exemption
✓Not exempt
Public agency evaluates project to determine if there is a possibility that the project may have a significant effect on environment
✓Possible significant effect
Notice of exemption may be filed
No further action required under CEQA
Determination of lead agency where more than one public agency is involved
Responsible Agency
Lead Agency
Respond to informal consultation
CONSULTATION
Lead agency prepares initial study
Lead agency decision to prepare EIR or negative declaration
✓EIR
Negative declaration
Respond to notice of preparation as to contents of draft EIR
CONSULTATION
Lead agency sends notice of preparation to responsible agency
Lead agency prepares draft EIR
Comments on adequacy of draft EIR or negative declaration
CONSULTATION
Lead agency files notice of completion and gives public notice of availability of draft EIR
Lead agency gives public notice of availability of negative declaration
✓Public review period
Public review period
Decision-making body considers final EIR or negative declaration prepared by lead agency
Lead agency prepares final EIR including responses to comments on draft EIR
Findings on feasibility of reduction or avoiding significant environmental effects
Consideration and approval of final EIR by decision-making body
Consideration and approval of negative declaration by decision-making body
Decision on permit
Findings on feasibility reducing or avoiding significant environmental effects
Decision on project
✓State agencies
✓Local agencies
File notice of determination with office of planning and research
File notice of determination with county clerk
✓State agencies
✓Local agencies
File notice of determination with office of planning and research
File notice of determination with county clerk

Figure 4-1. CEQA process flow chart

Source: Adapted from California Natural Resources Agency, 2013.

4.4.3 CEQA-Plus Requirements

If SRF financing is planned for the project, federal agencies are afforded the opportunity to review the environmental documents. This initiates the "CEQA-Plus" process, which requires the project to meet additional federal requirements, some of which are described in Section 4.4.1 (NEPA Requirements). CEQA-Plus requirements include compliance with the following regulations:

- Section 7 of the federal ESA
- Section 106 of the National Historic Preservation Act
- Federal Clean Air Act
- Migratory Bird Treaty Act
- Wild and Scenic River Act
- Protection of Wetlands
- Floodplain Management
- Farmland Protection Policy Act
- Coastal Zone Management Act

Section 5: Future Policy Recommendations

This section is a placeholder to tee up concepts for considerations throughout the project. Policy recommendations will be incorporated into the Draft Master Plan.

5.1 Opportunities for Unified Local Policies

This section is a placeholder for any potential unified local policies. This could include a discussion on onsite reuse, and the information and gaps surrounding its regulation (San Francisco Public Utilities Commission [SFPUC] ordinance, SB 966 – Weiner Bill).

5.2 Other Potential New Policies

This section is a placeholder for any potential new policies. This could include a discussion of recommended new policies that could facilitate implementation of the Master Plan.

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Use of contents on this sheet is subject to the limitations specified at the beginning of this document. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

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Appendix C: Hydraulic Modeling

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Appendix C-1: Modeling Plan and Results

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Appendix C-2: SBWR System Master Plan TM

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Appendix D: Project Definition, Roles, and Responsibilities

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Appendix D-1: Project Definition, Roles, and Responsibilities

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Technical Memorandum

Prepared for:	Santa Clara Valley Water District (Valley Water)
Project title:	Countywide Water Reuse Master Plan
Project no.:	4821 (Valley Water); 151772 (BC Internal)
Contract no.:	A4120A

Appendix D

Subject:	Project Definition, Roles, and Responsibilities
Date:	April 27, 2018 (reissued June 30, 2020)
To:	Miguel Silva, Valley Water Project Manager
From:	Jenny Gain, BC Team Project Manager
Copy to:	David Tucker, Valley Water Assistant Project Manager

Prepared by: Jenny Gain, Brown and Caldwell

Reviewed by: Mary Hoang, HydroScience Engineers

Limitations:

This document was prepared solely for Santa Clara Valley Water District (Valley Water) in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for the partners, regulatory agencies, and stakeholders contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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List of Abbreviations

ABAG	Association of Bay Area Governments
AF	acre-foot/feet
AFY	acre-foot/feet per year
AWPF	advanced water purification facility
BARR	Bay Area Regional Reliability
BAWSCA	Bay Area Water Supply and Conservation Agency
BAO	Board Appointed Officer
CEO	Chief Executive Officer
CIP	capital improvement program
County	Santa Clara County
DDW	Division of Drinking Water
DPR	direct potable reuse
DWR	(California) Department of Water Resources
EIR	environmental impact report
EL	Executive Limitation
ELG	Executive Leadership Group
IAP	Independent Advisory Panel
IPR	indirect potable reuse
IRWM	integrated regional water management
JWRC	Joint Recycled Water Committee
L	liter(s)
Master Plan	Countywide Water Reuse Master Plan
mg	milligram(s)
mgd	million gallons per day
MOU	memorandum of understanding
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NWRI	National Water Research Institute
PA/MV RWS	Palo Alto/Mountain View Recycled Water System
PPG	Project Partner Group
PR	potable reuse
Project	Countywide Water Reuse Master Plan Project
RO	reverse osmosis
ROCM	reverse osmosis concentrate management
RWC	Recycled Water Committee
RWF	Regional Wastewater Facility
RWPAC	Recycled Water Policy Advisory Committee
RWQCP	Regional Water Quality Control Plant
RWS	recycled water system
SBWR	South Bay Water Recycling
SCRWA	South County Regional Wastewater Authority
SFB	San Francisco Bay
SFEP	San Francisco Estuary Partnership
SFPUC	San Francisco Public Utilities Commission
SJWC	San Jose Water Company
Strategic Plan	Northwest County Recycled Water Strategic Plan
SVAWPC	Silicon Valley Advanced Water Purification Center
TDS	total dissolved solids
TF	Task Force
TM	technical memorandum
TPAC	Treatment Plant Advisory Committee
UWMP	Urban Water Management Plan
WPCP	water pollution control plant
WRA	water reuse alternative
WSCP	Water Shortage Contingency Plan
Valley Water	Santa Clara Valley Water District

Executive Summary

The Countywide Water Reuse Master Plan (Master Plan) aims to improve water supply reliability through water reuse for Santa Clara County in collaboration with recycled water producers, wholesalers, retailers, users, and other interested parties. The Master Plan will identify how much water will be available for potential potable reuse development and non-potable reuse expansion, the optimal allocation between potable and non-potable reuse, options for system integration, recommendations for building upon non-potable reuse projects and creating new potable reuse projects, and proposals for governance model alternatives, including roles and responsibilities. This technical memorandum will be used to inform the final Master Plan to be completed in early 2021 to guide reuse in the County through 2040.

Building on the Success of Existing Partnerships

Santa Clara Valley Water District (Valley Water) policies include a goal to meet at least 10 percent of the County's total water demands by 2025 using water reuse. Valley Water's Water Supply Master Plan 2040 includes a reuse target to achieve 33,000 acre-feet per year (AFY) of non-potable reuse and 24,000 AFY of additional reuse in the County by 2040. To achieve this goal, Valley Water is building on its partnerships with four non-potable reuse systems in the County, referred to as Partner Agencies, to integrate existing plans and infrastructure. The Partner Agencies include:

1. **Palo Alto/Mountain View Recycled Water System (RWS).** Valley Water is currently working with Palo Alto and Mountain View to evaluate water reuse alternatives, including planned construction of a 1.25 to 2.5 million gallons per day Advanced Water Purification Facility (AWPF) near the Palo Alto Regional Water Quality Control Plant to reduce salinity of recycled water, and a potential larger regional AWPF to produce purified water for future potable reuse.
2. **South Bay Water Recycling (SBWR).** SBWR is a collaboration between the San José/Santa Clara Regional Wastewater Facility (RWF) and Valley Water. The RWF produces recycled water for SBWR to sell to retailers, including the City of San José, City of Milpitas, San Jose Water Company, and the City of Santa Clara. In 2014, Valley Water also collaborated with the City of San José in creating the Silicon Valley Advanced Water Purification Center, which produces purified water currently added back into the SBWR system to improve water quality.
3. **South County Regional Wastewater Authority (SCRWA).** In 1999, SCRWA partnered with Valley Water to create a master plan and capital improvement program, and agreed Valley Water would sell by wholesale recycled water produced by SCRWA to the City of Gilroy. Valley Water has also partnered with entities in the Gilroy area to construct new pipelines and extend the South County RWS.
4. **Sunnyvale RWS.** Starting in 2013, Valley Water partnered with Sunnyvale on the Wolfe Road pipeline design and construction. The pipeline is designed to deliver recycled water from the RWS to Apple Inc. in Cupertino, with Valley Water as the wholesaler and California Water Company as the retailer. Valley Water and Sunnyvale are jointly evaluating additional water reuse alternatives, including an AWPF near the Sunnyvale Water Pollution Control Plant.

Collaborating to Advance Water Reuse in Santa Clara County

In developing the Master Plan, Valley Water is leading an engagement strategy that involves staff and executive-level participation from Partner Agencies, along with a diverse group of stakeholders, regulators, an independent advisory panel, and the public. The outreach process will document commitments and future goals, acknowledge and find solutions to barriers, and define common goals. Achieving substantial agreement on conceptual project alternatives and identifying alternatives for preliminary design will be key to producing a successful Master Plan and implementing water reuse solutions for years to come.

Section 1: Purpose and Scope

The Santa Clara Valley Water District (Valley Water) initiated the Countywide Water Reuse Master Plan (Master Plan) Project (Project) to improve water supply reliability through water reuse for Santa Clara County's (County's) nearly 2 million residents and growing economy. Valley Water's strategy for meeting this goal is twofold: (1) to integrate and expand existing recycled water systems and (2) to develop purified water systems within Santa Clara County, in partnership with recycled water producers, wholesale and retail water suppliers, end users, and other interested parties. The Master Plan will provide a framework to make collaborative decisions and implement integrated actions to increase water supply reliability throughout the region. Decisions will be informed through technical assessment of key criteria applied to allocate available wastewater flows and integrate centralized/decentralized and potable/non-potable options. The Master Plan's planning horizon extends through 2040.

There are many drivers for diversifying and expanding the county's water supply portfolio, including population/economic growth, increasing climate uncertainty, and other challenges to supply resilience. Recent technological advancements and regulatory developments have made it possible for Valley Water to pursue water reuse as a viable local, drought-resistant supply.

To address several specific objectives (adjacent text box), the scope of this Master Plan involves developing interim deliverables that build on one another as elements of the Master Plan, including the following technical memoranda (TM) and reports and their respective purpose.

- **Project Definition, Roles and Responsibilities** – Establishes the project's purpose and describe roles and responsibilities of Valley Water and its Partner Agencies.
- **Regulations Framework** – Describes key regulations applicable to non-potable and potable reuse applications that must be considered when developing water alternatives.
- **Baseline Analysis** – Establishes a Countywide baseline of existing reuse facilities and projects, assesses reuse supply availability, and identifies information gaps.
- **Geotechnical and Geo-Environmental Preliminary Study** – Compiles existing information about geotechnical and geo-environmental characteristics of a potential reuse facility site in Sunnyvale
- **Modeling Plan** – Describes the planned approach for updating Partner Agencies' existing hydraulic models of non-potable reuse systems, and the **Hydraulic Model Results** that provide completed and calibrated hydraulic models for all non-potable reuse systems in the County, and summarizes the results of hydraulic model simulations.

Project purpose:
To improve Santa Clara County's water supply reliability through water reuse

Master Plan objectives:

- **Determine reuse supply availability and benefits.** Identify sources and amounts of water available for reuse; the appropriate split between potable and non-potable reuse; and regional, Valley Water, and local-level benefits from NPR and PR.
- **Evaluate potential regional integration.** Facilitate innovative approaches and collaboration for residuals management, permitting, and land use decisions. Optimize use of supply and infrastructure, improve system reliability and flexibility, and explore redefining sewersheds.
- **Guide system expansion through interagency agreements and governance**. Analyze the economics of project alternatives and explore cost-sharing opportunities
- **Generate regional support for the Master Plan via coordination and outreach.** Improve public perception of water reuse through outreach programs.

- **Conceptual Alternatives** – Assesses the County's reuse market, identifies and evaluates conceptual project alternatives, groups project alternatives into portfolios, describes the portfolios' prioritization and assessment methodology, and identifies a residuals management plan for alternatives involving advanced water purification facility (AWPF) options.
- **Preliminary Draft Master Plan** – Provides a high-level summary of items 1 through 4 above to update Valley Water's Board.
- **Feasible Project Portfolios** – Presents preliminary designs, costs, and a risk assessment and evaluation of project portfolios.
- **Draft Master Plan Report** – Presents a summary of items 1 through 8 above (including interim TMs and studies as appendices) and assesses regulatory compliance options.
- **Final Master Plan Report** – Refines the Draft Master Plan considering feedback from Valley Water, Partner Agencies, and external stakeholders.

For the purposes of this Master Plan, terms are defined as follows:

- **Recycled water or non-potable reuse (NPR)** – Water that originated from homes and businesses as municipal wastewater and has undergone a high degree of treatment at a reclamation facility to meet specific water quality standards so that it can be beneficially reused for a variety of non-potable purposes.
- **Purified water or potable reuse (PR)** – Water of wastewater origin treated with methods at least as effective as membrane filtration, reverse osmosis (RO), advanced oxidation, disinfection, or other equivalent treatment as approved by State Water Resources Control Board Division of Drinking Water (DDW). Advanced levels of treatment are used so that the purified water can be added to water supplies and ultimately used for drinking water.
- **Enhanced Recycled Water (NPR+)** – NPR water that has been blended with PR water to reduce total dissolved solids (TDS) and improve water quality.
- **Reuse** – As a shorthand, the term reuse applies to both NPR and PR.

Section 2: Countywide Reuse Vision

For more than a decade, Valley Water has methodically advanced water reuse in the county by participating in planning efforts, developing wholesale recycled water programs, and constructing new infrastructure. Now, Valley Water is broadening the reuse vision to focus on a collaborative, countywide strategy. Leveraging existing partnerships, expertise, and technical resources, the Master Plan will identify reliable sources of water supply to increase regional self-reliance and integrated water management in Santa Clara County.

Countywide reuse vision:

> "A collaboration to integrate and expand recycled and purified water as a local, reliable, environmentally adaptive, drought-resistant water supply and guide strategic investment of public funds over the next 20 years."

2.1 Background

Understanding the countywide reuse vision requires understanding the history of recycled water use in Santa Clara County, the roles and responsibilities of Valley Water, and existing recycled water planning documents.

2.1.1 District Mission

Valley Water's mission is to provide safe, clean water for a healthy Santa Clara County community, environment, and economy. The county's water supplies originate from multiple sources, including naturally occurring groundwater, local surface water, imported water (e.g., water imported from the Sacramento-San

Joaquin Delta), and local recycled water. As policies and public perceptions have progressed over time, recycled water has become an integral component of Valley Water's existing and future water supply portfolio.

2.1.2 History of Recycled Water Within Santa Clara County

Major exploration and evaluation of water reuse as a drought-resistant water supply in the county began in the 1970s (Figure 2-1).

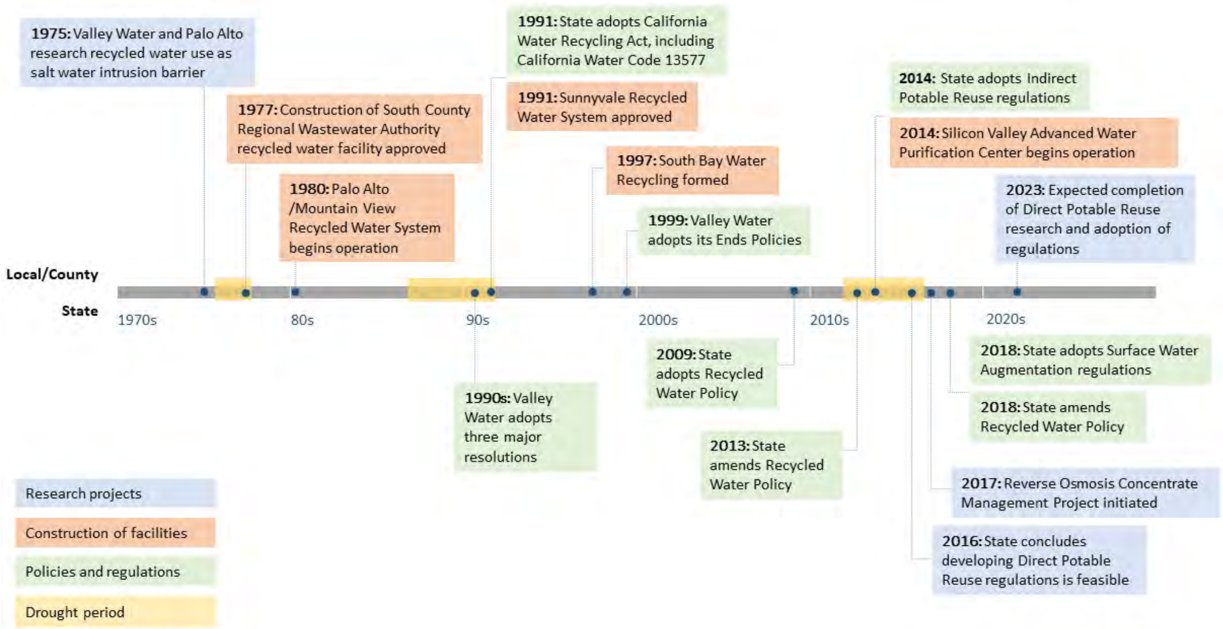

1975: Valley Water and Palo Alto research recycled water use as salt water intrusion barrier
1977: Construction of South County Regional Wastewater Authority recycled water facility approved
1980: Palo Alto /Mountain View Recycled Water System begins operation
1991: State adopts California Water Recycling Act, including California Water Code 13577
1991: Sunnyvale Recycled Water System approved
1997: South Bay Water Recycling formed
1999: Valley Water adopts its Ends Policies
2014: State adopts Indirect Potable Reuse regulations
2014: Silicon Valley Advanced Water Purification Center begins operation
2023: Expected completion of Direct Potable Reuse research and adoption of regulations
Local/County
State
1970s
80s
90s
2000s
2010s
2020s
1990s: Valley Water adopts three major resolutions
2009: State adopts Recycled Water Policy
2013: State amends Recycled Water Policy
2018: State adopts Surface Water Augmentation regulations
2018: State amends Recycled Water Policy
2017: Reverse Osmosis Concentrate Management Project initiated
2016: State concludes developing Direct Potable Reuse regulations is feasible
Research projects
Construction of facilities
Policies and regulations
Drought period

Figure 2-1. The evolution of recycled water policies (local/county and state) and actions within Santa Clara County

In 1975, Valley Water and Palo Alto constructed an advanced wastewater reclamation pilot plant to research the feasibility of using recycled water as a saltwater intrusion barrier. Drought conditions in the late 1970s led to the construction of the first recycled water facility in the county, the South County Recycled Water System (RWS) located in Gilroy to support agricultural irrigation. Several years later, the Palo Alto/Mountain View Recycled Water System (PA/MV RWS) began operation. Changes to state discharge regulations, coupled with population and business growth, led to construction of the City of Sunnyvale RWS in 1991 and the formation of South Bay Water Recycling (SBWR) in 1997, which treats effluent from the San José/Santa Clara Regional Wastewater Facility (RWF) for NPR. These four separate public water reuse systems still deliver recycled water within the county today, and were developed to meet the individual water supply and wastewater discharge needs of each of the stakeholder agencies within these service areas.

Valley Water adopted three major resolutions in the 1990s in support of recycled water use:

- Resolution 90-62 supported recycled water as a new supply (1990)
- Resolution 93-55 adopted policy for non-potable recycled water (1993)
- Resolution 93-55 was rescinded and replaced with Resolution 97-60, which reaffirmed Valley Water's commitment to recycled water (1997)

These resolutions marked Valley Water's initial recycled water policies and continue to guide Valley Water today.

In 2006, Valley Water worked with City of San José on planning an advanced recycled water facility. In 2014 (during the most recent drought cycle), Valley Water, in partnership with the City of San José, constructed the Silicon Valley Advanced Water Purification Center (SVAWPC), an 8 million gallon per day (mgd), state-of-the-art advanced water treatment facility that includes microfiltration, RO, and ultraviolet light disinfection. The facility also includes a pilot-scale advanced oxidation processes system. SVAWPC has been used to test and demonstrate the continued performance of advanced treatment technologies for producing highly treated water (purified water) to be used for indirect potable reuse (IPR) and/or potential direct potable reuse (DPR) applications. SVAWPC currently sends purified water to the SBWR system for NPR water quality enhancement (NPR+).

In 2017, Valley Water initiated a reverse osmosis concentrate management (ROCM) project to evaluate viable alternatives for managing RO concentrate from potential advanced water purification facilities that could be built in the county. The ROCM project includes evaluating treatment alternatives and RO concentrate discharge options. Valley Water is also exploring innovative RO concentrate treatment technology through a pilot-scale engineered open-cell treatment system at SVAWPC.

The successful operation of SVAWPC, along with these advanced technology and research studies, have established a foundation for regional discussions on the feasibility and development of PR projects. Furthermore, recent statewide regulatory developments have put the future feasibility of developing PR projects within the current planning horizon.

Historical recycled water delivery data for the four NPR systems and SVAWPC are shown on Figure 2-2. While purified water produced by SVAWPC is currently blended with SBWR recycled water, Figure 2-2 identifies SVAWPC production in blue to distinguish its volume. As the majority of non-potable recycled water in Santa Clara County is used for outdoor irrigation, recycled water demand tends to increase during periods of drought (such as 2012-2014).

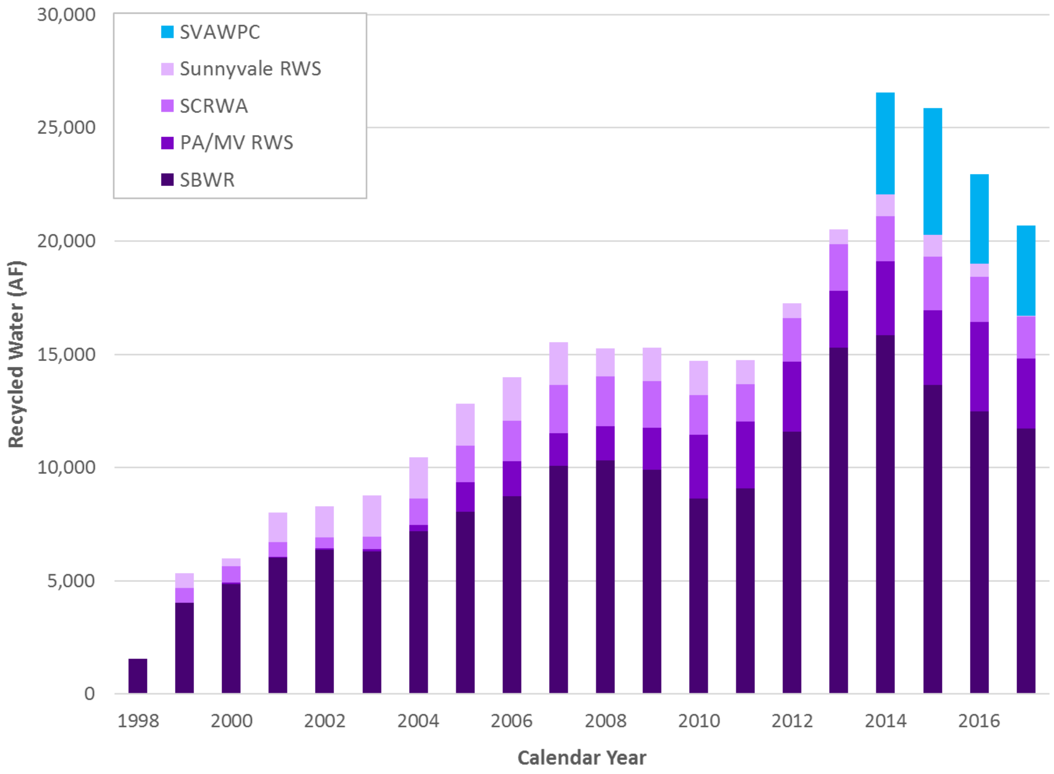


Figure 2-2. Trends in non-potable recycled water deliveries: 1998 to 2016

2.1.3 Valley Water Authority, Policies, and Strategies

Valley Water's authority, structure and Board-directed policies have an influence on all of Valley Water's projects, including the Master Plan. Valley Water staff and Board/committee members have also developed a specific strategy surrounding water reuse that will guide the Master Plan.

2.1.3.1 District Act

The District Act defines Valley Water's authority and responsibility to conserve and manage recycled water; to obtain, retain, protect, and recycle treated wastewater; to store water in surface or underground reservoirs; and to conserve, reclaim, recycle, distribute, store, and manage water for present and future use within Valley Water. These objectives have been further refined through management plans, policies, and agreements with various stakeholders within the county.

2.1.3.2 Board's Ends Policies

Valley Water's commitment to expand the use of recycled water in Santa Clara County was reaffirmed through the Board's adoption of its Ends Policies in 1999. These Ends Policies describe the mission, outcomes, or results to be achieved by Valley Water staff. Board Appointed Officer (BAO) interpretations, including the Chief Executive Officer's (CEO) interpretations, further guide implementation of the Ends Policies by identifying strategies and outcome measures (Figure 2-3). Ultimately, Ends Policies influence Valley Water spending; Executive Limitation (EL)-4 states that financial planning must not deviate from Board's Ends Policies or fail to be derived from a multi-year plan.

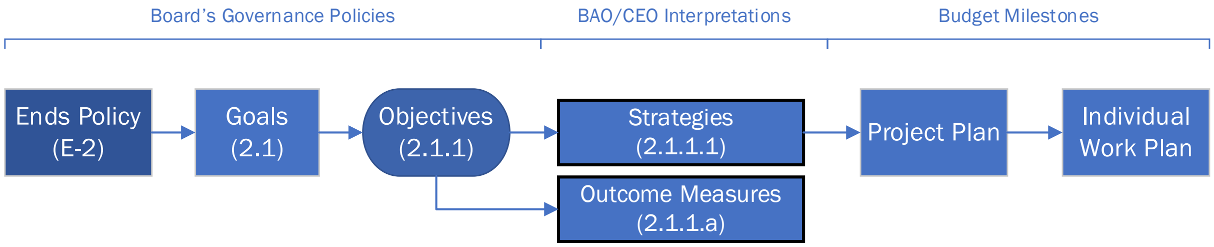
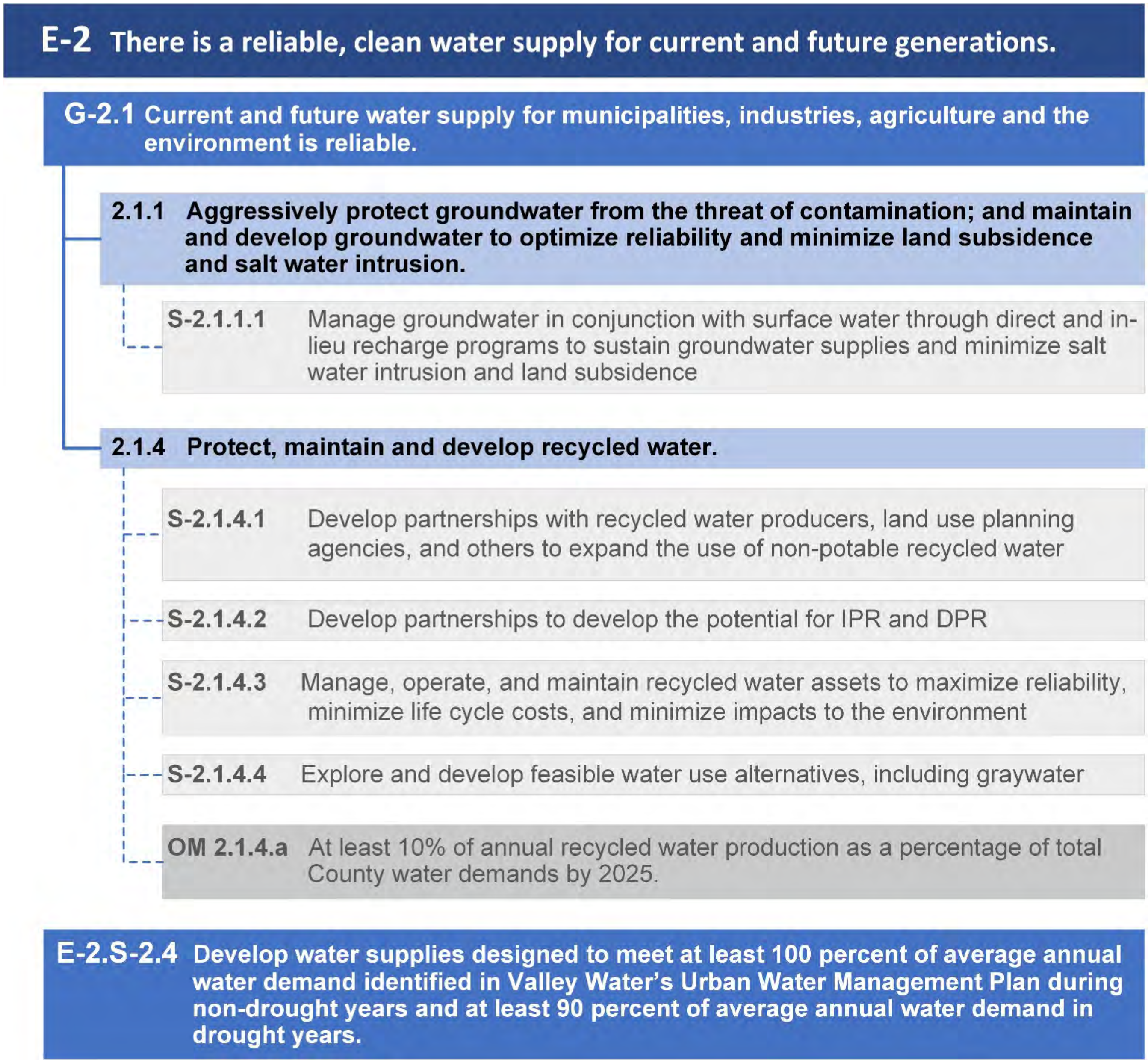


Figure 2-3. Framework of Valley Water Ends Policies: Board decisions through implementation by Valley Water staff

Recycled water objectives and strategies fall under Valley Water Board's Ends Policy E-2 (Figure 2-4). This policy pertains to overall water supply operations and requires that "there is a reliable, clean water supply for current and future generations." Further, the policy establishes an objective to "protect, maintain and develop recycled water." Several strategies were established to help meet this objective, along with an outcome measure: to sustain at least 10 percent of annual recycled water production as a percentage of total county water demands by 2025. Valley Water also has objectives and strategies related to groundwater recharge programs, which relate to IPR.



E-2 There is a reliable, clean water supply for current and future generations.

- **G-2.1** Current and future water supply for municipalities, industries, agriculture and the environment is reliable.
  - **2.1.1** Aggressively protect groundwater from the threat of contamination; and maintain and develop groundwater to optimize reliability and minimize land subsidence and salt water intrusion.
    - **S-2.1.1.1** Manage groundwater in conjunction with surface water through direct and in-lieu recharge programs to sustain groundwater supplies and minimize salt water intrusion and land subsidence
  - **2.1.4** Protect, maintain and develop recycled water.
    - **S-2.1.4.1** Develop partnerships with recycled water producers, land use planning agencies, and others to expand the use of non-potable recycled water
    - **S-2.1.4.2** Develop partnerships to develop the potential for IPR and DPR
    - **S-2.1.4.3** Manage, operate, and maintain recycled water assets to maximize reliability, minimize life cycle costs, and minimize impacts to the environment
    - **S-2.1.4.4** Explore and develop feasible water use alternatives, including graywater
    - **OM 2.1.4.a** At least 10% of annual recycled water production as a percentage of total County water demands by 2025.

E-2.S-2.4 Develop water supplies designed to meet at least 100 percent of average annual water demand identified in Valley Water's Urban Water Management Plan during non-drought years and at least 90 percent of average annual water demand in drought years.

Figure 2-4. Valley Water Ends policy, goal, objectives, strategies, and outcome measures related to water reuse

The latest revision for E-2 and related goals and objectives occurred on August 20, 2012.

The latest BAO interpretations (strategies and outcome measures) for E-2 occurred on April 2, 2019.

2.1.4 Existing Plans

To support its goals and strategies, Valley Water and its regional partners develop planning documents that guide countywide water supply development, including:

- Water Supply Master Plan 2040 (2019; reviewed annually)
- Groundwater Management Plan (2016; updated every five years)
- 2015 Urban Water Management Plan (finalized in 2016)
- NPR planning: Partner Agencies' individual recycled water master plans
- PR planning, including Expedited Purified Water Program Plan (2018) and ROCM Plan (2019)

2.1.4.1 Groundwater Management Plan

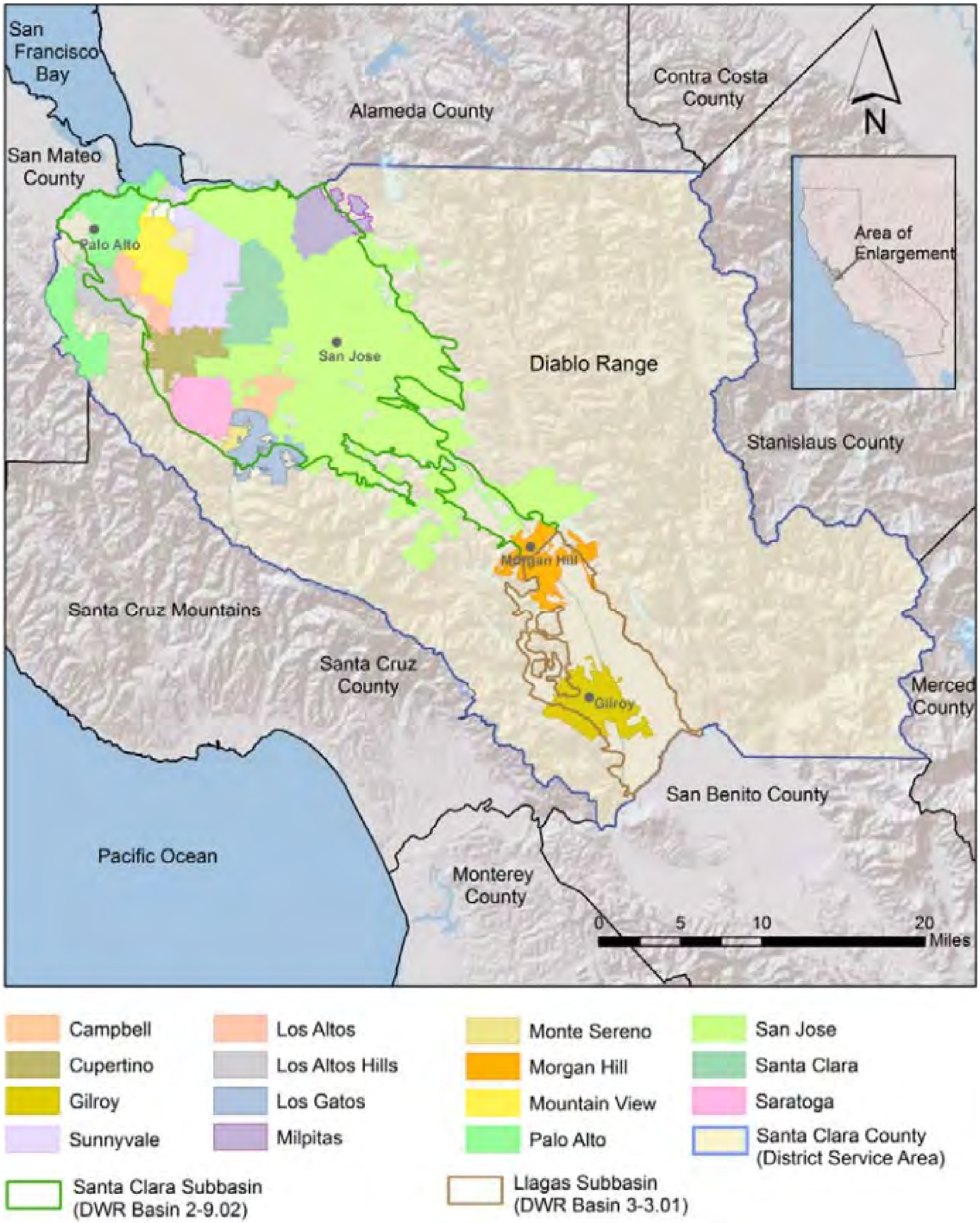
Santa Clara County includes portions of two groundwater basins as defined by the California Department of Water Resources (DWR): the Santa Clara Valley Basin and the Gilroy-Hollister Valley Basin. The two primary subbasins managed by Valley Water are the Santa Clara Subbasin and the Llagas Subbasin (Figure 2-5). As part of Valley Water's Groundwater Management Plan, two basin management objectives were established:

- Manage groundwater supplies to optimize water supply reliability and minimize land subsidence.
- Protect groundwater from existing and potential contamination.

Strategies to achieve these objectives include:

- Managing groundwater in conjunction with surface water through direct and in-lieu recharge programs.
- Implementing programs to protect or promote groundwater quality to support beneficial uses.
- Maintaining and developing adequate groundwater models and monitoring systems.
- Working with regulatory and land use agencies to protect recharge areas, promote natural recharge, and prevent groundwater contamination.

Thus, Valley Water can optimize the role of water reuse in supplementing the local water supply and managing the groundwater subbasins through a combination of direct replenishment (e.g., purified recycled water via IPR) and in-lieu recharge to reduce groundwater pumping via DPR (to supplement a water treatment plant) and NPR. In addition, reuse can help optimize water supply and provide Valley Water greater flexibility in water transfers. By recharging the groundwater subbasins with purified water in lieu of imported water, Valley Water could offset its imported water supplies.



Source: Valley Water, "Groundwater Management Plan." 2016

Figure 2-5. Santa Clara and Llagas Subbasins

2.1.4.2 Urban Water Management Plan and Water Shortage Contingency Plan

Valley Water's 2015 Urban Water Management Plan (UWMP) projects continued business and population growth and identifies a need to develop reliable local water supplies, including recycled water. It summarizes the county's current and projected PR and NPR water demands up to 2040, including local agency NPR systems. In 2015, NPR composed about 5 percent (or about 20,000 acre-feet per year [AFY]) of the county's supply.

As part of the UWMP, Valley Water's Water Shortage Contingency Plan (WSCP) defines its drought triggers and response actions. As noted in the WSCP, Valley Water maximizes storage of wet period supplies for use during dry periods when other sources of supply are insufficient to meet demands. Also as noted, Valley Water coordinates drought response actions closely with retailers, cities, and the County to minimize water shortages and hardships to communities, establish water use reduction targets, and maintain and safeguard essential water supplies for public health and safety needs.

2.1.4.3 Integrated Regional Water Management

Valley Water participates in two integrated regional water management (IRWM) efforts: the San Francisco Bay (SFB) Area IRWM and the Pajaro River Watershed IRWM.

The SFB Area IRWM, last updated in October 2019, describes water management goals, strategies, and projects within nine SFB Area counties, including Santa Clara. The SFB Area IRWM covers the following four functional areas:

- Water supply and water quality
- Wastewater and recycled water
- Flood protection and stormwater management
- Watershed management and habitat protection and restoration

The 2019 SFB Area IRWM brings together existing countywide and local plans and describes Valley Water's existing efforts to expand recycled water use.

The Pajaro River Watershed IRWM, last updated in October 2019, was developed collaboratively by the Pajaro Valley Water Management Agency, the San Benito County Water District, and Valley Water. It lays out goals for the watershed, strategies for its management, and potential upcoming projects. It refers to the 2004 South County Recycled Water Master Plan and 2015 Master Plan update for recycled water use projections (3,700 AFY by 2021).

2.1.4.4 Water Supply Master Plan 2040

Valley Water lays out a vision for meeting future water demands through 2040 in its Water Supply Master Plan 2040 (Valley Water, 2019) and includes recycled water projections for the county through 2040. Valley Water's 2019 Water Supply Master Plan identifies a need for 24,000 AFY of reuse supply, in addition to the UWMP's projected 33,000 AFY supply of NPR, to meet county water supply demands by 2040. This combined total of 57,000 AFY reuse water is expected to exceed Valley Water's minimum goal of 10 percent recycled water within the county.

2.1.4.5 NPR Planning: Partner Agencies' Individual Recycled Water Master Plans

Past reuse planning in the county has been focused on each of the four NPR systems (referred to as the "Partner Agencies") on an individual basis. The following studies establish a foundation for NPR planning relative to each system:

- PA/MV RWS
  - City of Palo Alto Recycled Water Facility Plan, prepared by the City of Palo Alto (December 2008)
  - City of Mountain View Recycled Water Facility Plan, City of Mountain View (March 2014)
  - Advanced Water Purification System Feasibility Study (May 2017)
  - Northwest County Recycled Water Strategic Plan (July 2019)
- SBWR
  - South Bay Water Recycling Strategic and Master Planning, prepared by the SBWR and Valley Water (December 2014)
- SJWC
  - San José Recycled Water Master Plan, San Jose Water Company, 2009 and updated in January 2011
- South County Recycled Wastewater Authority (SCRWA)
  - 2015 South County Recycled Water Master Plan Update, prepared by Valley Water and SCRWA in collaboration with the cities of Gilroy and Morgan Hill (May 2016)
  - Sustainable Water Management Planning, City of Gilroy and City of Morgan Hill (September 2019)
- Sunnyvale
  - City of Sunnyvale Feasibility Study for Recycled Water Expansion Report, City of Sunnyvale (June 2013)

2.1.4.6 PR Studies and Program Plan

Though IPR and DPR have not yet been implemented in the county, the need and opportunities for PR are captured by various planning studies. Valley Water's 2012 Water Supply and Infrastructure Master Plan set the initial framework for potential IPR and DPR opportunities. The 2014 SBWR Strategic and Master Planning Report built upon the 2012 Water Supply and Infrastructure Master Plan and identified potential pathways for up to 35,000 AFY of PR. Additionally, Valley Water has performed groundwater management studies to evaluate the feasibility of groundwater augmentation via IPR.

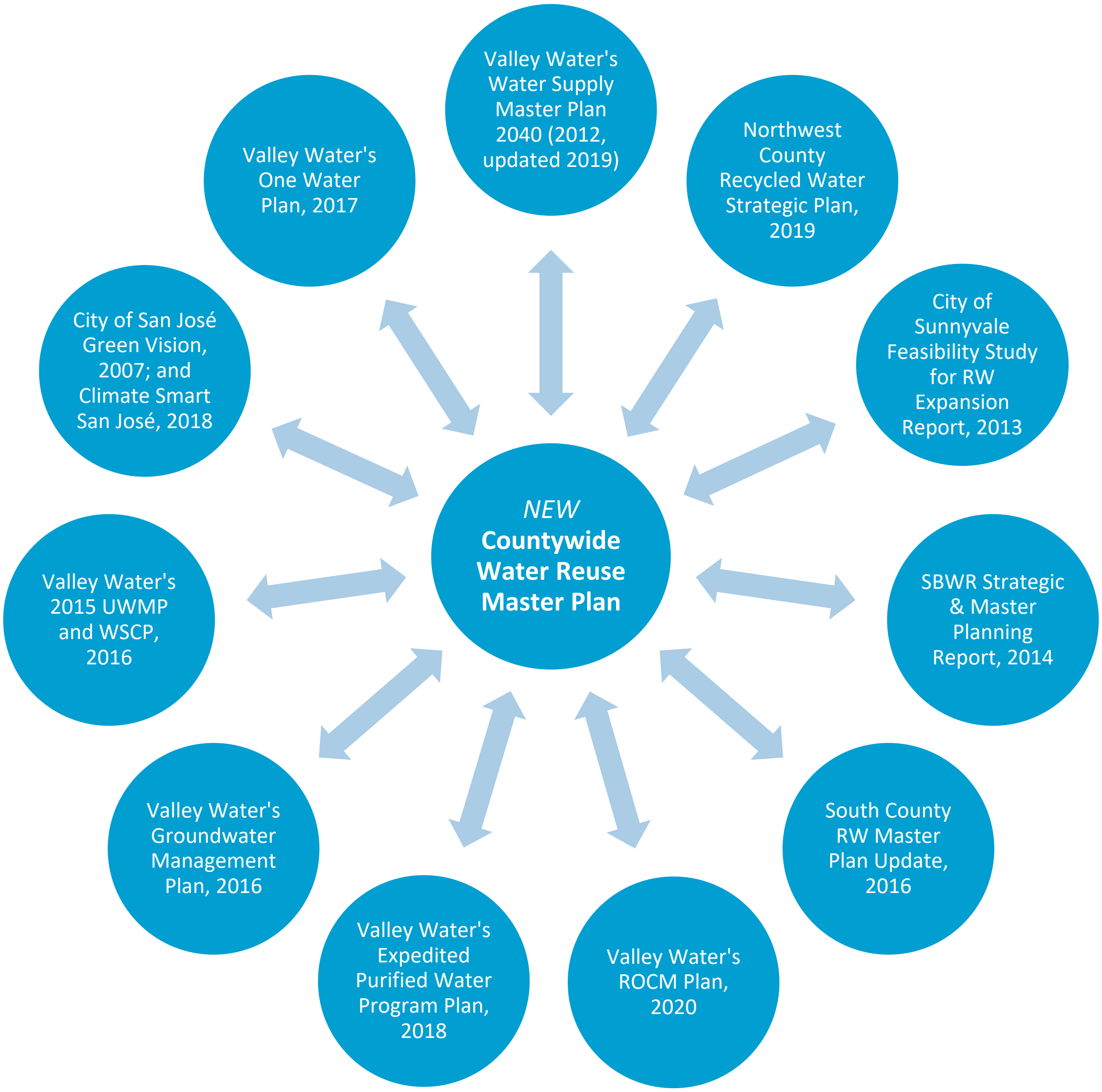
Valley Water's April 2018 Expedited Purified Water Program Plan assessed various PR project components, developed and evaluated project alternatives, and recommended an initial plan for implementation by 2025 that could provide up to 24,000 AFY of supply via advanced purification. Valley Water's water supply modeling indicated that providing up to 24,000 AFY of PR would complement other water supply sources to meet projected demands. The plan also identified future expansion options that could provide up to a total of 45,000 AFY of purified water, should it be needed to meet future water supplies. These options were further evaluated and incorporated into the Water Supply Master Plan 2040 released by Valley Water in late 2019.

The ROCM Plan is currently evaluating treatment alternatives for managing RO concentrate generated by the expansion of SVAWPC and other AWPF in the County. The plan is expected to be completed by mid-2020.

2.1.5 Master Plan

Valley Water initiated a process to integrate reuse planning and develop a comprehensive water reuse master plan for the County. The process began with stakeholder workshops in May 2016 and January 2017 to gain consensus on commitment to endorse regional planning for recycled and purified water, frame a vision, and identify key components for this Master Plan. Attendees included agency managers from local recycled water producers, wholesalers, and retailers, along with other public representatives (e.g., business interests and environmental non-governmental organizations).

This Master Plan will build on existing plans by integrating information and further evaluating the potential for collaboration (Figure 2-6). The Master Plan will identify how to optimize recycled and purified water supplies and infrastructure, improve sustainability and reliability of water reuse, expand NPR, develop PR, and integrate water reuse infrastructure in the county from a regional planning perspective.


Valley Water's Water Supply Master Plan 2040 (2012, updated 2019)
Northwest County Recycled Water Strategic Plan, 2019
City of Sunnyvale Feasibility Study for RW Expansion Report, 2013
SBWR Strategic & Master Planning Report, 2014
South County RW Master Plan Update, 2016
Valley Water's ROCM Plan, 2020
Valley Water's Expedited Purified Water Program Plan, 2018
Valley Water's Groundwater Management Plan, 2016
Valley Water's 2015 UWMP and WSCP, 2016
City of San José Green Vision, 2007; and Climate Smart San José, 2018
Valley Water's One Water Plan, 2017
NEW Countywide Water Reuse Master Plan

RW = recycled water

Figure 2-6. Master Plan integration of relevant Valley Water and Partner Agency planning studies

A full list of the documents referenced on Figure 2-6 is summarized in Attachment A.

The Master Plan will evaluate NPR and PR pathways to achieve Valley Water's recycled water targets by 2040. For NPR, alternatives for infill, expansion to new service areas, and interties to connect existing systems will be considered. For PR, alternatives for IPR and DPR will be considered, as well as a strategy to leverage existing facilities (Figure 2-7).

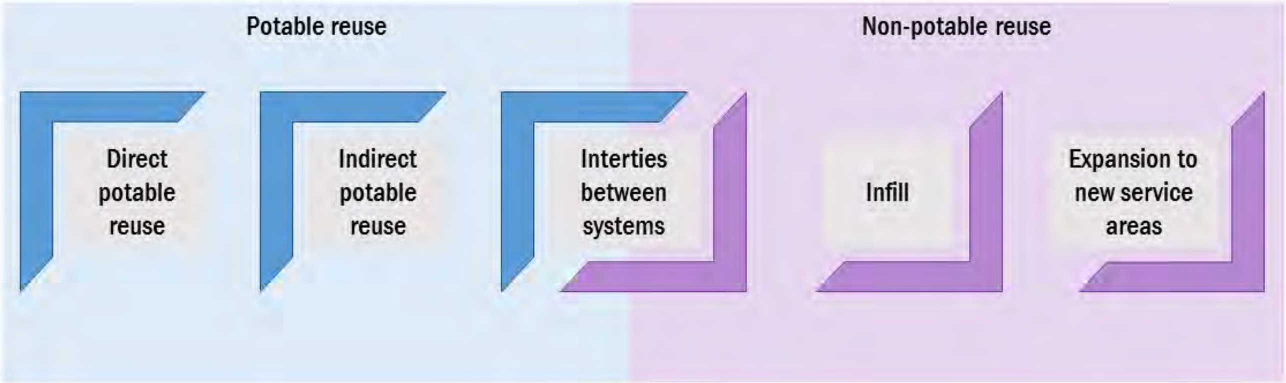
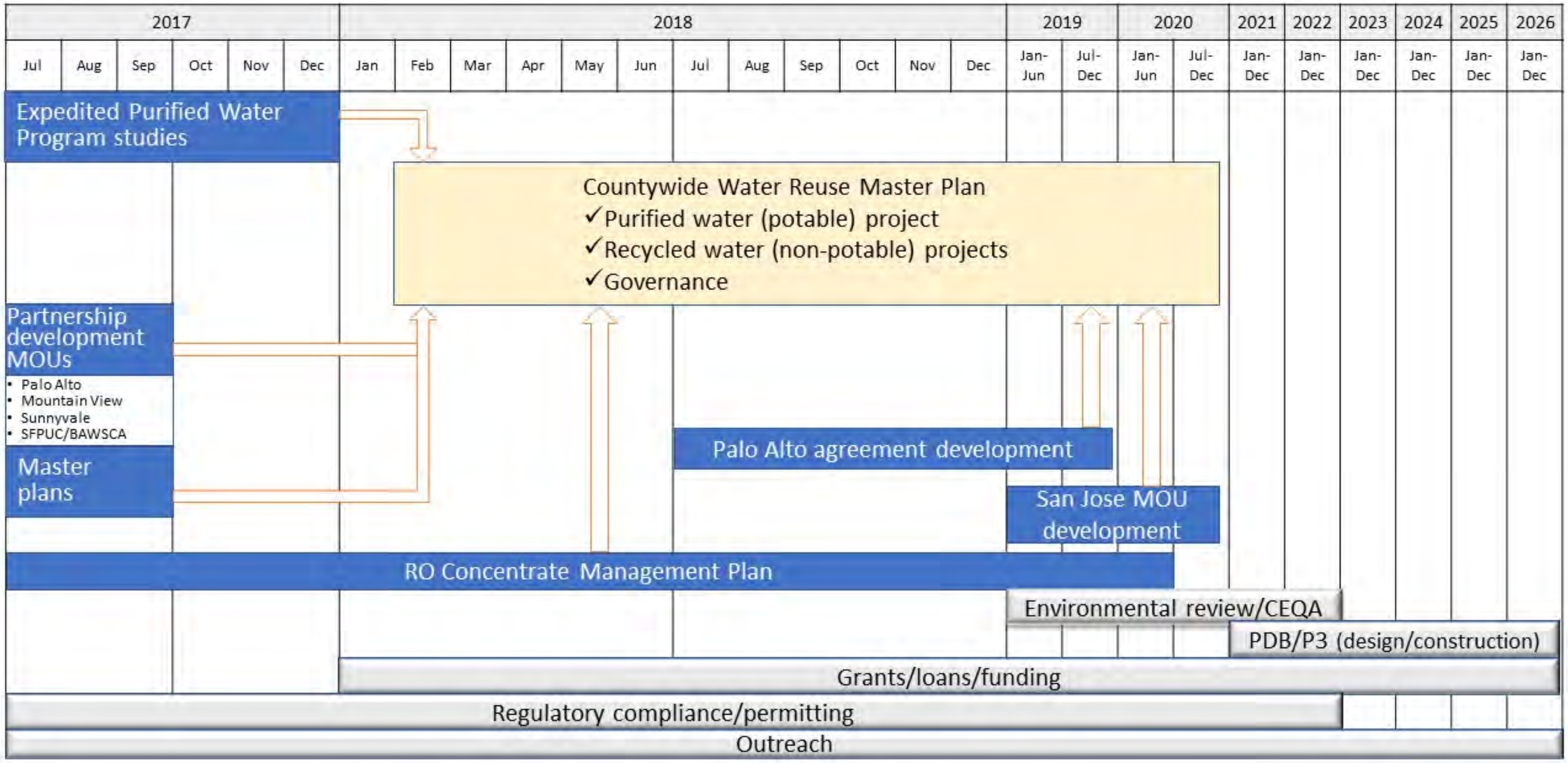


Figure 2-7. Recycled water pathways

The Master Plan will guide strategic investments in NPR and PR for both the near term (10 to 15 years) and long term (20+ years). The projected timeline for all work related to the Master Plan as of mid-2018 is shown on Figure 2-8.



BAWSCA = Bay Area Water Supply and Conservation Agency

SFPUC = San Francisco Public Utilities Commission

PDB = Progressive Design Build

Figure 2-8. Water reuse program timeline as of April 2018

2.2 Study Area and Water Resources

To achieve the countywide reuse vision, partnerships with recycled water producers (i.e., the four existing NPR systems and SVAWPC), wholesalers, and retailers are necessary (Figure 2-9). The recycled and purified water produced at these facilities is then distributed either by a wholesaler to retailers, or directly by retailers to end users (Figure 2-10).

The **Palo Alto Regional Water Quality Control Plant (RWQCP)** receives wastewater flows from Palo Alto, East Palo Alto Sanitary District, Stanford University, Los Altos, Los Altos Hills, and Mountain View. RWQCP produces recycled water and distributes it in Palo Alto on a retail basis, and sells it to the City of Mountain View on a wholesale basis for distribution in Mountain View city limits. In 2015, RWQCP produced 1,268 acre-feet (AF) of recycled water, including utility flows.

The **San José/Santa Clara RWF** receives wastewater flows from the City of San José (co-owner of RWF), City of Santa Clara (co-owner of RWF), Milpitas, Cupertino, Los Gatos, Saratoga, Monte Sereno, and County Sanitation District 2-3 (Tributary Agencies). In the 1990s, the City of San José and Valley Water collaborated on planning the SBWR system, driven by the RWF's National Pollutant Discharge Elimination System (NPDES) permit effluent limitations and projected population growth. SBWR is the recycled water producer and wholesaler while the City of Milpitas, City of Santa Clara, San José Municipal Water System, and San José Water Company are retailers. Additionally, the Silver Creek Pipeline Agreement allows Valley Water to serve as wholesaler for 5 mgd of SBWR water within a dedicated service area. In 2015, the SJ/SC RWF produced nearly 10,000 AF of recycled water.

Under Partnership Agreements entered in 2010 between the City of San José and Valley Water, SVAWPC was constructed and began operations in 2014. The purified water produced at SVAWPC is blended with the RWF's NPR recycled water to improve the water quality and reduce TDS within the SBWR system. In 2015, SVAWPC produced more than 5,000 AF of purified water.

SCRWA receives wastewater flows from Gilroy and Morgan Hill and sends tertiary treated effluent to the South County RWS for use by the City of Gilroy. SCRWA is the recycled water producer, Valley Water is the wholesaler, and the City of Gilroy is the retailer. In 2015, SCRWA produced about 2,100 AF of recycled water, including utility flows.

Sunnyvale Water Pollution Control Plant (WPCP) receives flows from the City of Sunnyvale and sends tertiary treated effluent to the Sunnyvale RWS for retail in Sunnyvale. For the recently constructed 2.5-mile-long Wolfe Road Pipeline, Sunnyvale is the producer and retailer of recycled water for most of the City recycled water distribution system. Valley Water wholesales recycled water to the California Water Service Company to retail along the Wolfe Road recycled water pipeline. This pipeline was designed to serve customers south of the San Lucar Pump Station and within Cupertino. In 2015, Sunnyvale WPCP produced approximately 3,100 AF of recycled water, including utility flows.

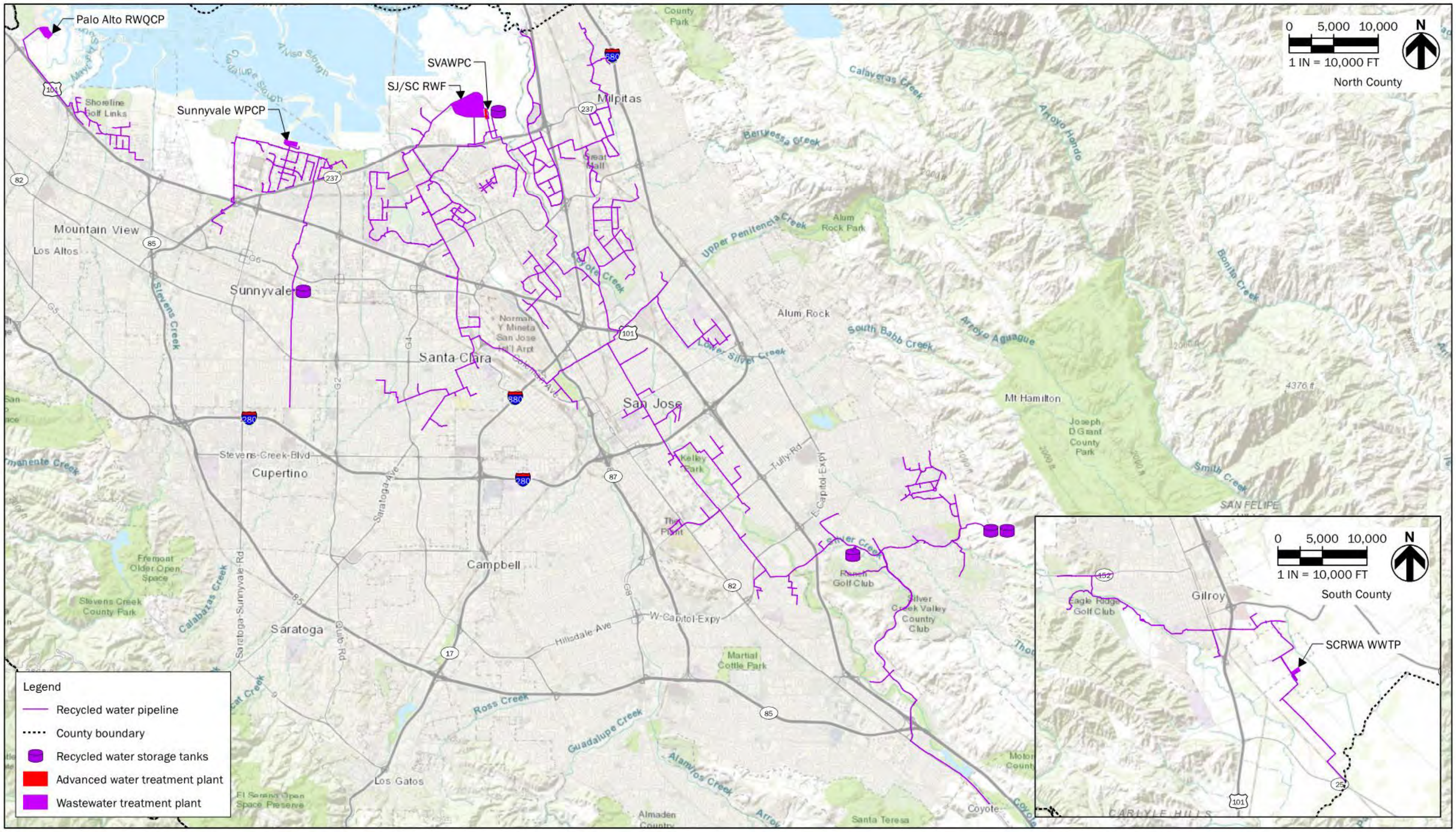


Figure 2-9. Study area and existing recycled water systems

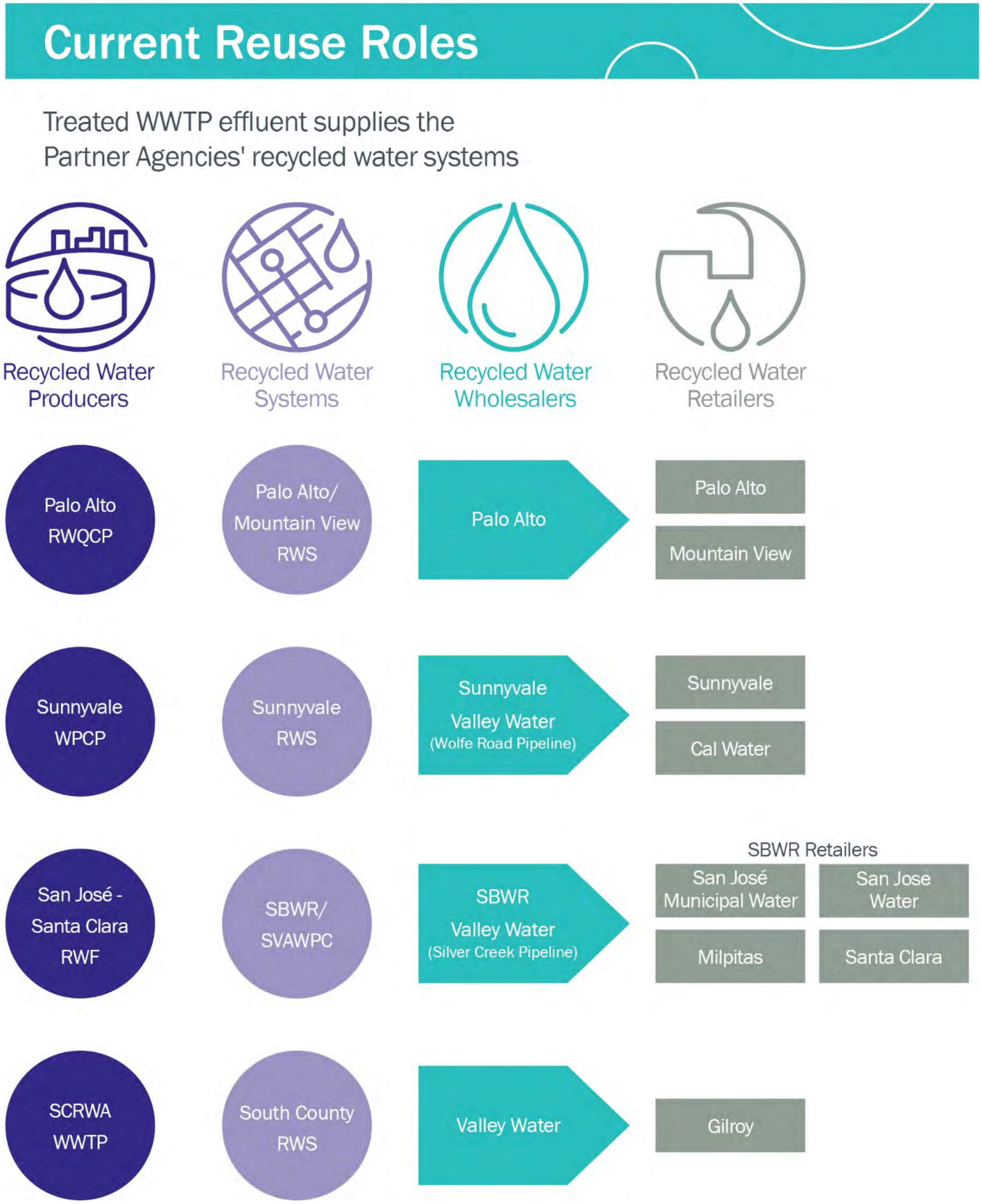


Figure 2-10. Existing Santa Clara County recycled and purified water suppliers

Section 3: Roles and Responsibilities

Valley Water's collaboration with the Partner Agencies is critical to expanding Countywide water reuse. Current and future agreements outline each agency's roles and responsibilities, described below.

3.1 Valley Water Roles and Responsibilities

Valley Water is governed by a seven-member Board of Directors comprising elected representatives from seven geographical districts in the county who serve overlapping 4-year terms. The Board directs Valley Water's CEO, who oversees the work of Valley Water staff. Valley Water's roles and responsibilities are shaped primarily by California state law (i.e., the District Act) along with various Valley Water policies and institutional agreements with other parties. Additionally, Valley Water is considered an independent "special district" (i.e., "any agency of the state for the local performance of governmental or proprietary functions within limited boundaries").[1] These agencies derive their authority from separate generic statutes that apply to all special districts of that type (e.g., municipal water districts). They are formed by the Local Agency Formation Commission and require voter approval in the geographic area influenced by fees and services. Special districts are governed by elected boards and provide only services allowed by state law.

Today, Valley Water's roles include water supply, flood protection, and stream stewardship. Table 3-1 summarizes Valley Water's roles that relate to water reuse and associated responsibilities.

Table 3-1. Valley Water Roles and Responsibilities Pertaining to Water Reuse

Role	Valley Water's Responsibility
Regional leadership	Engages in regional water supply planning and coordinates with regional partners.
Water retailer assistance	Meets regularly with the local water retailers to provide information, offer technical support, and help develop regional alliances. There are currently 13 major water retailers in Santa Clara County.
Water conservation programs leader	Leads water conservation efforts with innovative, effective, and comprehensive-in-scope programs.
Local surface water leader	Operates and maintains 20 appropriative water rights licenses and one filed water right permit with the State Water Resources Control Board totaling more than 227,300 AFY.
Ensure sustainability leadership	Develops strategies to secure and optimize the use of existing water supplies and infrastructure and to expand water recycling and long-term water conservation savings. Valley Water is also working with seven local water agencies to optimize the sharing of water resources regionally, known as Bay Area Regional Reliability (BARR).
ROCM leader	Leads workshops with stakeholders in a collaborative process to develop ROCM solutions, in addition to conducting pilot-scale testing of treatment alternatives.
Groundwater management	Leads groundwater management efforts for Santa Clara County through comprehensive programs and investments, including storage of surface water in groundwater basins and in-lieu recharge to help balance pumping and provide reserves for use during dry years.

To meet the objective of purified water development within the county, partnerships and collaborations among recycled water producers, wholesalers, retailers, users, and other interested parties are necessary. Current relationships exist between Valley Water and the Partner Agencies operating the County's four NPR systems (PA/MV RWS, SBWR, SCRWA, Sunnyvale RWS), along with other stakeholders. The Master Plan will guide continuing collaborations and future potential partnerships.

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[1] Government Code §16271 [d]

3.2 Regulatory Responsibilities

Valley Water, its Partner Agencies, and other retailers in the area have varying regulatory responsibilities. NPR producers are responsible for meeting Title 22 requirements, complying with Water Reclamation Orders, and ensuring discharges from facilities meet NPDES permit quality requirements. NPR retailers must enforce Title 22 Use Area Requirements by monitoring recycled water customers/users. PR producers are responsible for meeting more stringent quality requirements, depending on direct or indirect application. PR wholesalers and retailers do not share regulatory responsibilities. Descriptions of regulations, including specific regulatory requirements for potable reuse, are included in the Regulations Framework TM (Appendix B-2).

3.3 Past and Current Reuse Partnerships

Valley Water has executed agreements and memorandums of understanding (MOU) related to reuse with external partners, including Partner Agencies and private companies, as summarized in Attachment B (organized by Partner Agency service areas and chronological order) and described in further detail in the following subsections. While some of these agreements have common traits (characterized as the “type” of agreement in this TM), they vary in terms of subject, cost to each party, and recycled water transfer opportunity.

Valley Water’s agreements to date with the PA/MV RWS relate to:

- Cost-sharing and flow commitments related to constructing, managing, and operating a salinity removal facility (called the Local Plant) to produce 1.25 mgd of enhanced recycled water for the RWQCP service area, and an AWPF (called the Regional Plant) capable of treating effluent flows of 9 mgd or greater to benefit the regional water supply .
- Joint planning or feasibility studies to examine water reuse alternatives (WRA).

Agreements between Valley Water and the City of San José/SBWR fall into three general categories:

- Cost-sharing for the development/expansion and use of SBWR
- Cost-sharing for managing and operating the Silver Creek pipeline
- Cost-sharing and flow commitments related to constructing, managing, and operating SVAWPC

Valley Water’s agreements with SCRWA fall into two categories:

- Defining the producer-wholesaler relationship, including roles/responsibilities, costs/prices, and flows (with prices and flows negotiated annually)
- Cost-sharing related to new pipeline construction and operation

Agreements between Valley Water and Sunnyvale fall into two categories:

- Cost-sharing and/or flow commitments for the new Wolfe Road pipeline
- Cost sharing and responsibilities for joint feasibility studies to examine WRAs

3.3.1 Palo Alto/Mountain View Recycled Water System

Recycled water collaboration between Palo Alto and Valley Water dates back to the 1970s. In March 2014, Valley Water and Palo Alto initiated policy-level discussions on recycled water that resulted in the May 2014 formation of the Joint Recycled Water Committee (JRWC).

In May 2016, Valley Water, Palo Alto, and Mountain View partnered to share consultant support costs related to development of the “Advanced Water Purification System Feasibility Study” published in May 2017. The feasibility study evaluates treatment technologies, concentrate management, permitting, costs, and schedule for constructing an AWPF to be used for enhancing the quality of PA/MV’s RWS supply to create NPR+ supply. The study recommends phased implementation of the NPR+ AWPF, starting with a 1.125-mgd Phase 1 facility located at the RWQCP, increasing to 2.25 mgd capacity as part of Phase 2. Phase 3 involves constructing a 4.5-mgd facility at a nearby site that requires voter support to allow use of the land.

In December 2016, Valley Water, Palo Alto, and Mountain View agreed to share consultant support costs in revising RWQCP's 1992 Water Reclamation Master Plan to create the Northwest County Recycled Water Strategic Plan (Strategic Plan), finalized in March 2020. The Strategic Plan includes evaluating:

- NPR expansion opportunities within the RWQCP service area and additional portions of East Palo Alto and Menlo Park not served by the East Palo Alto Sanitary District. The highest-ranked NPR option involves expanding the PA/MV RWS to the Stanford Research Park area along Page Mill Road and then to Purissima Park, Fremont Hills Country Club, Palo Alto Hills Country Club, and Foothills Park.
- Palo Alto-based IPR opportunities, such as an alternative involving injection of approximately 2,800 AFY into wells located in Palo Alto's Downtown and Professorville neighborhoods, and installation of new groundwater supply wells to supplement existing imported potable supply.
- Palo Alto-based DPR opportunities, such as an alternative involving construction of a new DPR AWPF located near the RWQCP, 4.75 million gallons of engineered storage, and pipelines to connect the storage tank to three separate points in Palo Alto's potable water distribution system.

In August 2017, Valley Water and Palo Alto signed an MOU to affirm the parties' commitments to study the feasibility of WRAs. including:

- A Valley Water-constructed and -owned AWPF in Palo Alto
- Water recharge and reuse alternatives identified in the Strategic Plan
- Future development and governance of Palo Alto's NPR system

The MOU also states that Valley Water will evaluate opportunities for Palo Alto to transfer up to 10 mgd of effluent to Valley Water. RO concentrate will be the responsibility of Valley Water, although the City of Palo Alto agrees to work with Valley Water on RO concentrate management. In addition, Palo Alto will help Valley Water identify and permit land for constructing a future AWPF. In October 2017, Valley Water and Mountain View signed a similar MOU to affirm the parties' commitments to study the feasibility of water reuse alternatives.

In December 2019, Palo Alto, Mountain View, and Valley Water executed a long-term agreement to replace the 2017 MOU that ensures Valley Water a minimum of 9 mgd of source water supply for regional potable reuse over 75 years. The agreement also defines a plan for Valley Water to provide $16 million toward the construction of an AWPF to enhance recycled water quality operated by Palo Alto.

3.3.2 South Bay Water Recycling System

The San José/Santa Clara RWF is governed by the Treatment Plant Advisory Committee (TPAC) and the City of San José Council. TPAC consists of representatives from the co-owners and Tributary Agencies. These organizations make policy and budget decisions related to SBWR to prioritize the interests and needs of the facility and the sanitary sewer ratepayers of San José, Santa Clara, and the Tributary Agencies. The City of San José serves as the Administrative Agency for the RWF and SBWR. San José and Valley Water have a long history of recycled water collaboration and partnerships on SBWR financing and funding pursuits. Collaborative efforts date back to the early 1990s. The first major agreement between Valley Water and City of San José was the April 1998 cost-sharing agreement for development and use of SBWR.

The SBWR Collaborative was initiated in 2002 and led to past long-term agreements that guided RWF and Valley Water collaboration. The SBWR Collaborative established objectives relevant to the ownership of the SBWR system and concluded that:

- It is advantageous for the RWF and Valley Water to work together to maximize recycled water beneficial uses.
- Enhancing the quality of recycled water is key to increasing beneficial uses.
- A long-term agreement between the RWF and Valley Water was needed.

The following sections describe current collaborations between Valley Water and the City of San José in detail.

3.3.2.1 SBWR Expansion and Silver Creek Pipeline

In 2002, Valley Water and City of San José entered into a 25-year agreement to develop an institutional framework for long-term ownership, operation, maintenance, and future expansion of SBWR and cost-sharing to develop the Silver Creek Pipeline. Per the agreement, the City owns the pipeline and acts as wholesaler for recycled water to be delivered to the Metcalf Energy Center and other end users within the Evergreen and Edenvale service areas by the San José Municipal Water System. Valley Water has rights to 5 mgd of recycled water from the Silver Creek pipeline with the potential for more, depending on availability.

3.3.2.2 Integration Agreement and Ground Lease and Property Use Agreement

The 40-year Integration Agreement provides a framework for the City of San José and Valley Water to financially and administratively support SVAWPC and the cost-effective, environmentally beneficial production and use of recycled water in Santa Clara County consistent with each party's separate and distinct interests: wastewater treatment and disposal for the City of San José, and water quality and supply for Valley Water. It specifies the formation of a Recycled Water Policy Advisory Committee (RWPAC) composed of elected officials from San José, Santa Clara, and Valley Water; the formation of Technical Working Groups comprising staff from the cities of San José and Santa Clara and Valley Water to advise the RWPAC; and the RWF's contribution to advanced water purification and Valley Water's contributions to SBWR operations. Additionally, the agreement states that prior to July 1, 2020, export of secondary treated wastewater or recycled water out of the county is not allowed by either party. After July 1, 2020, if demand for in-county use of recycled water is less than available supply, each party may engage in negotiations for out-of-county export of secondary treated wastewater or recycled water. The agreement expires in July 2050.

The 40-year Ground Lease and Property Use Agreement describes responsibilities for constructing and operating SVAWPC and related facilities on a portion of the WPCP premises. It also requires Valley Water to accept up to 12 mgd of secondary treated effluent, and operate and maintain SVAWPC to provide up to 8 mgd of purified water to blend with existing recycled water and produce blended recycled water with TDS levels of about 500 milligrams per liter (mg/L).

3.3.2.3 Operation and Maintenance Agreement for the SVAWPC

In December 2016, Valley Water and City of San José entered into a 34-year Operations and Maintenance Agreement for SVAWPC. The agreement defines roles and responsibilities and requires the RWF to accept 1.5 mgd of waste stream discharge and 2 mgd of RO concentrate. The agreement expires in June 2050 along with the Integration and Ground Lease and Property Use Agreements.

3.3.3 South County Recycled Water System

SCRWA's recycled water system began operating in 1977, but operated intermittently because of demands and variabilities in recycled water quality up until the 1990s. In October 1999, Valley Water entered into a series of three 20-year producer-wholesaler agreements establishing SCRWA as the producer, Valley Water as wholesaler, and the City of Gilroy as retailer of recycled water. These agreements detail roles and responsibilities and establish cost-sharing for a master plan and capital improvement program (CIP). As part of the agreements, SCRWA may sell flows of recycled water that exceed the Annual Delivery Quantity (a mutually agreed-upon flow established each year) to other wholesalers/end users, and Valley Water may sell water to be used by end users outside of the producer's service area (with approval by SCRWA).

As a result of the 1999 agreements, the initial South County Recycled Water Master Plan, completed in late 2004, identified recycled water capital investment projects to improve the South County recycled water system's reliability and to expand the use of recycled water. Per the agreements, updated in 2006, the parties shall work together to update, at 5-year intervals, the Master Plan for the design and construction of expanded recycled water production and distribution facilities. The most recent Master Plan update occurred in 2016. In December 2010, Valley Water and SCRWA signed an MOU defining roles and responsibilities for constructing the South County Pipeline extension to the Pajaro River to deliver recycled water to agricultural customers during spring, summer, and fall. SCRWA will pay all costs for and own the pipeline extension, and Valley Water will pay for and own irrigation turnouts from the pipeline. Two additional agreements between Valley Water, the City of Gilroy, and private developers in February 2015 resulted in additional pipeline extensions. Private developers agreed to pay for the design and construction of pipelines, while Valley Water contributed funds to increase the size of pipelines beyond the developments' required capacities. Valley Water will assume ownership of both pipelines when construction is complete.

In July 2011, Valley Water agreed to transfer ownership of three recycled water meters to the City of Gilroy in exchange for Gilroy reporting water usage data to Valley Water.

3.3.4 Sunnyvale Recycled Water System

In December 2014, Valley Water and the City of Sunnyvale established a funding agreement to evaluate alternative plant layouts and facilities for the Sunnyvale WPCP with the goal of increasing electrical capacity and developing a potential AWPF that was conceptually evaluated at the time. In August 2016, the City of Sunnyvale adopted a WPCP Master Plan update with the goal of upgrading wastewater treatment systems through 2035 to produce suitable water for advanced purification. Valley Water agreed to work with the City of Sunnyvale to develop a site plan to be included in the WPCP Master Plan.

In fall 2013, Valley Water and Sunnyvale agreed to cost-share design of the Wolfe Road Pipeline. Subsequently, in early 2015, Valley Water, Sunnyvale, Apple Inc., and Cal Water agreed to cost-share the construction of the Wolfe Road Pipeline. Per the Recycled Water Supply/Distribution Agreement, Sunnyvale (producer) shall supply Valley Water (wholesaler) with recycled water to distribute to retailers from the Wolfe Road Pipeline and Sunnyvale will operate and maintain the pipeline (to be reimbursed by Valley Water). Additionally, Sunnyvale shall make available to Valley Water at least 500 AFY of recycled water for distribution outside the city and 595 AFY of recycled water for distribution within the city. Valley Water will make available for purchase by Sunnyvale at least 595 AF of recycled water for delivery to Sunnyvale's end users. Recycled water conveyed through the Wolfe Road Pipeline is owned by Valley Water and may be resold to Valley Water's other customers, including water retailers, regardless of whether their service areas are located within or outside Sunnyvale's service area.

In May 2016, Valley Water and Sunnyvale agreed to receive State Grant funds, administered by the Association of Bay Area Governments (ABAG) in partnership with the San Francisco Estuary Partnership (SFEP), of up to $4 million for the Sunnyvale Continuous Recycled Water Production Facilities and Wolfe Road Pipeline project. $1.5 million was to reimburse the City of Sunnyvale for the Continuous Recycled Water Production Facilities and $2.5 million to reimburse Valley Water for the Wolfe Road Pipeline project. The grant required $6 million in matching funds from Valley Water.

In June 2017, Valley Water and Sunnyvale signed an MOU agreeing to study the feasibility of WRAs. As part of the MOU, the parties identified three alternative plant layouts and facilities for the Sunnyvale WPCP upgrade. Two options involve an AWPF constructed by Valley Water on the Sunnyvale WPCP site, and the other involves an AWPF close to the WPCP site. Sunnyvale will help evaluate other options, including interties, a small-scale AWPF, and a pipeline to SVAWPC.

The MOU also states that Valley Water will evaluate opportunities for Sunnyvale to transfer up to 5 mgd of effluent from the Sunnyvale WPCP dual-media filters through 2020, and an additional 5 mgd of this effluent after 2020. Valley Water and Sunnyvale will develop a residuals management plan if any alternatives are implemented. The MOU states an assumption that Valley Water will be responsible for RO concentrate from a Valley Water-owned AWPF, and Sunnyvale will be responsible for salinity management of any NPR-related projects.

3.3.5 Other Agreements

This section describes other agreements outside of those affecting the Partner Agencies.

3.3.5.1 SFPUC/BAWSCA

Valley Water works with the San Francisco Public Utilities Commission (SFPUC) and the Bay Area Water Supply and Conservation Agency (BAWSCA) on regional water management. Several BAWSCA member agencies receive water from both Valley Water and SFPUC. In addition, Valley Water, SFPUC, and BAWSCA collaborate on the SFB IRWM and BARR.

In March 2017, Valley Water, SFPUC, and BAWSCA signed an agreement to cost-share consultant support services to evaluate alternatives for SFPUC/BAWSCA participation in Valley Water’s Expedited Purified Water Program, as Valley Water may develop capacity to produce additional water supplies that could be available to SFPUC, BAWSCA, and common customers.

3.3.5.2 Cinnabar Hills Golf Club

In October 2014, Valley Water entered into a cost-sharing agreement with Cinnabar Hills Golf Club (Cinnabar) in which Cinnabar leadership agreed to contribute funding toward recycled water development, which may directly or indirectly benefit Cinnabar by providing an alternative water source supply. In 2017, Valley Water prepared a preliminary feasibility analysis to size pumps and pipelines to potentially deliver recycled water to Cinnabar.

3.4 Considerations for Future Agreements

Each of the Partner Agencies has specific considerations/barriers that must be addressed to advance reuse and achieve the Project vision, as summarized by agency in Table 3-2. The nature of the considerations/ barriers spans a fairly broad range, from concerns about potential rate impacts as expressed by elected officials on behalf of their constituents to potential logistical and institutional barriers. In addition, the degree to which each consideration/barrier may affect agencies may vary considerably.

Table 3-2. Critical Path Considerations for Partnerships with Recycled Water Producers

Consideration/Barrier	Palo Alto RWQCP	San José/ Santa Clara RWF	Sunnyvale WPCP	SCRWA
1. Impacts to water and/or sewer rates resulting from reuse agreements and projects	✓	✓	✓	✓
2. Economic growth/development enabled by resulting supplies	✓	✓	✓	✓
3. Environmental demands/impacts resulting from changes in treated effluent flows to the San Francisco Bay	✓	✓	✓	
4. Effluent water quality (using existing treatment facilities) – Changes or degraded recycled water quality (e.g., due to saltwater intrusion in corroded distribution pipes), compromising the success of interties or other future collaborations between Partner Agencies and Valley Water.	✓	✓	✓	✓
5. RO concentrate management and NPDES permit compliance – A key consideration for future AWPF agreements.	✓	✓	✓	✓
7. Land use/property availability for new facilities	✓	✓	✓	
8. Bond financing – The SBWR system was partially funded by public bonds, and rules governing the sale of bond-funded assets to private entities are a consideration for and potential barrier to future agreements. SBWR bond and loan repayments will be complete in 2021. The bonds were series 2005A and 2009A issued by the San José-Santa Clara Clean Water Financing Authority ($54 million and $21.4 million, respectively) and a loan from the State Revolving Fund ($73.6 million).		✓		
9. Partner Agency barriers outside of Valley Water control – For example, SBWR has relationships with Tributary Agencies and Retailers that will affect the potential for future agreements between Valley Water and SBWR.	✓	✓		
10. Schedule – Sequencing implementation of capital improvement projects and aligning timelines across agencies.	✓	✓	✓	✓

3.5 Collaboration and Engagement

To develop and sustain a common vision for the region, robust engagement is needed across various interest groups and levels, including policymakers, Partner Agencies, stakeholders (external to Valley Water and Partner Agencies), industry experts, regulators, and the general public. All of these partners and stakeholders must work together to create a template for a new recycled water market within the county. Using a countywide market approach will enable agencies to enhance water supply reliability, leverage existing infrastructure investments, facilitate water transfers during critical shortages, and improve climate change resilience.

Moving forward, Valley Water's collaboration strategy will emphasize multiple levels of engagement (Figure 3-1), allowing staff, general managers, and stakeholders to be meaningfully engaged through scheduled meetings and strategic workshops to gain buy-in, generate support, and garner good will within the community. Meeting and workshop facilitation will start by empowering stakeholders with critical information to establish a clear, level baseline of working knowledge. This knowledge can then support productive group dialogue and decision making in many directly relevant and successful venues. Beyond large meetings and workshops, Valley Water will continue be involved with establishing partnerships and creating new institutional structures to support a common vision for the region. Proactively addressing governance issues will be a significant focus of the Master Plan, forging consensus among diverse stakeholders, documenting commitments, and articulating the vision in actionable master plans.

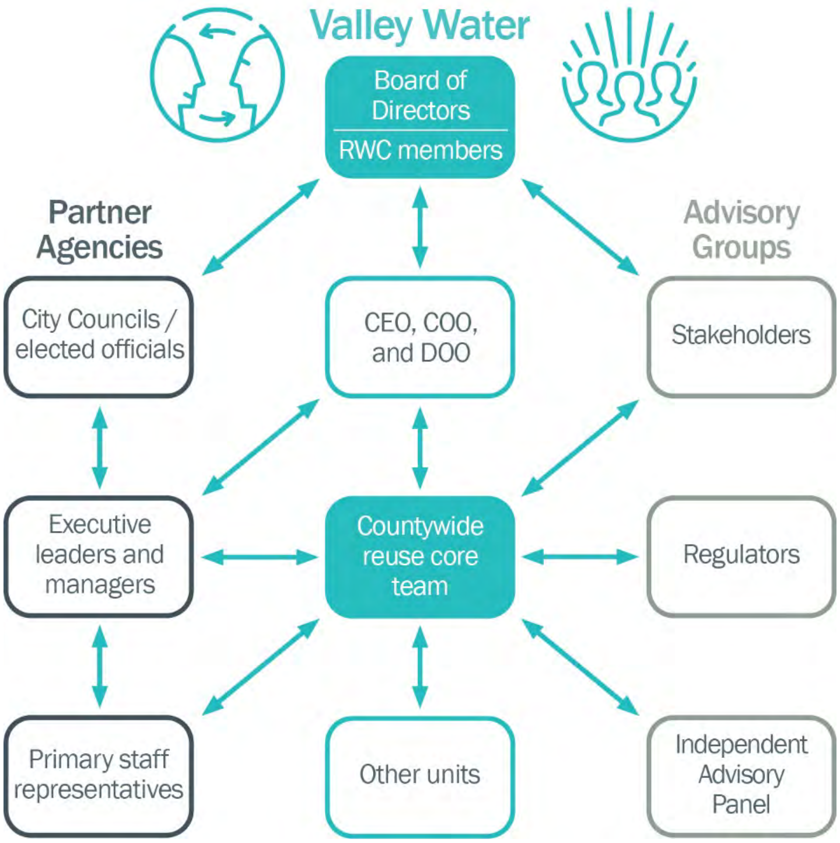
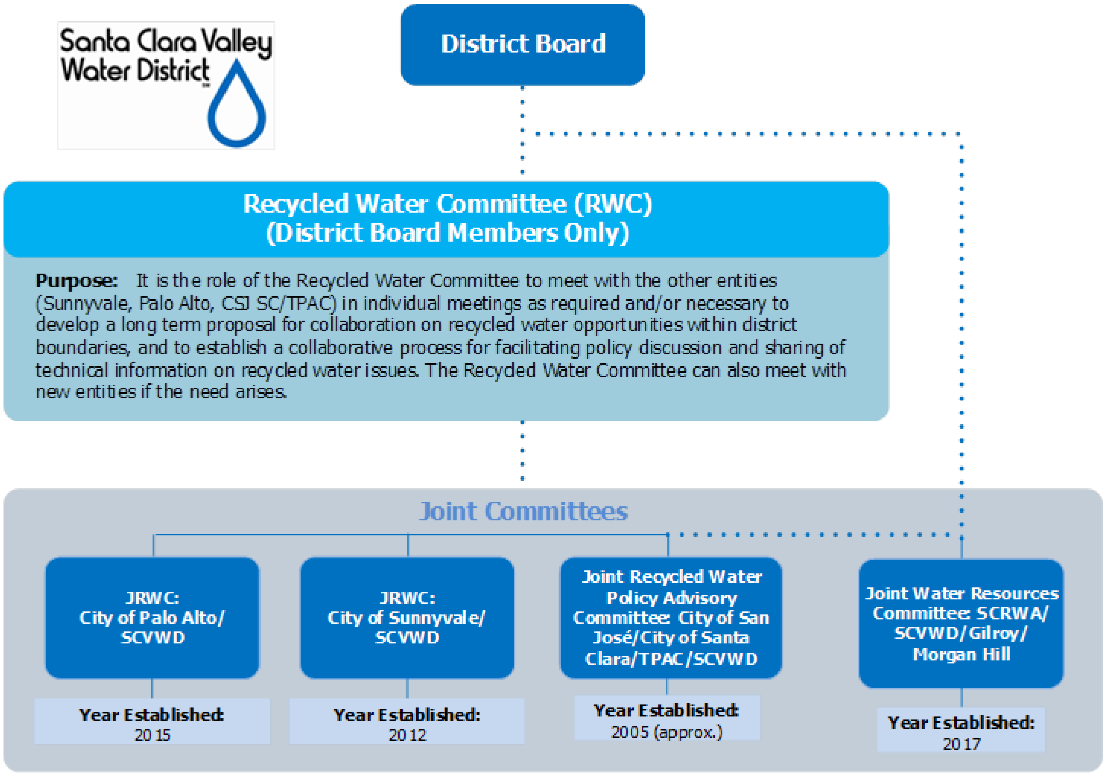

Valley Water
Board of Directors
RWC members
Partner Agencies
Advisory Groups
City Councils / elected officials
CEO, COO, and DOO
Stakeholders
Executive leaders and managers
Countywide reuse core team
Regulators
Primary staff representatives
Other units
Independent Advisory Panel

Figure 3-1. Levels of engagement to guide Master Plan development

3.5.1 Recycled Water Committees

Valley Water's Board formed a Recycled Water Committee (RWC), made up of three Board members, to facilitate collaboration among Valley Water and the four Partner Agencies. The RWC participates in three JWRCs as shown on Figure 3-2. A fourth JWRC is managed by Valley Water's full Board.


Santa Clara Valley Water District
District Board
Recycled Water Committee (RWC)
(District Board Members Only)
Joint Committees
JRWC: City of Palo Alto/ SCVWD
Year Established: 2015
JRWC: City of Sunnyvale/ SCVWD
Year Established: 2012
Joint Recycled Water Policy Advisory Committee: City of San José/City of Santa Clara/TPAC/SCVWD
Year Established: 2005 (approx.)
Joint Water Resources Committee: SCRWA/ SCVWD/Gilroy/ Morgan Hill
Year Established: 2017

Purpose: It is the role of the Recycled Water Committee to meet with the other entities (Sunnyvale, Palo Alto, CSJ SC/TPAC) in individual meetings as required and/or necessary to develop a long term proposal for collaboration on recycled water opportunities within district boundaries, and to establish a collaborative process for facilitating policy discussion and sharing of technical information on recycled water issues. The Recycled Water Committee can also meet with new entities if the need arises.

(Rev. 08/24/2017)

Figure 3-2. How Valley Water's Board and its recycled and purified water board committees interact

The Board JRWC members are elected officials who share technical information on recycled water issues and collaborate on policy decisions. They assist in developing and recommending policies to Valley Water Board and their respective city councils, as well as in providing high-level direction related to integrating and expanding recycled and purified water in the county.

The Master Plan is a recurring topic discussed at RWC and JRWC meetings. Periodic updates on the status of Master Plan development will be shared with the RWC/JRWCs to keep policymakers apprised of the progress and direction. In addition, many other topics regularly discussed during RWC meetings influence the Master Plan, and vice versa.

3.5.2 Partner Agencies

Valley Water is collaborating with the Partner Agencies at executive and staff levels to develop the Master Plan. During the outset of Master Plan development, Valley Water executives are holding individual (one-on-one) meetings with executives from individual Partner Agencies to understand their desired Project outcomes and explore a shared vision for advancing reuse countywide, before convening to meet as an ELG. The ELG is made up of the respective general manager, city manager, or public works director from each of the Partner Agencies, and its mission is to provide strategic input on the Project/partnerships' direction at key milestones and confirm partnership guiding principles.

After one-on-one executive meetings and before the first ELG meeting, Valley Water convened designated staff representatives from Valley Water and each Partner Agency for the first PPG meeting. Throughout development of the Master Plan, the PPG supported and informed technical Project aspects, represented their respective agency's interests, and provided continuity to past/ongoing work (studies, plans, projects, and programs).

Because the Project involves an update to the SBWR Recycled Water Master Plan, Valley Water held one-on-one meetings with SBWR retailers to review relevant information, assumptions, and early findings related to hydraulic scenarios, potential strategies, and prioritized actions to accommodate existing and future reuse demands.

3.5.3 Stakeholders

Valley Water formed a Stakeholder Task Force (TF) composed of representatives from agencies/organizations external to the Partner Agencies to provide feedback through the Master Plan development, including interim work products and reuse alternatives. The TF process provides stakeholders an opportunity for substantive engagement on the development at key milestones.

In addition to stakeholders involved in Valley Water's two countywide reuse workshops that preceded Project initiation, Valley Water invited representatives from a broad range of interest groups to participate, including non-utilities (chambers of commerce and organizations representing business interests, planning, public policy, environmental, environmental justice, diversity, and stormwater) and utilities (potable and recycled water retailers, wholesale water suppliers, and wastewater/recycled water agencies from the broader region). To enable meaningful engagement, the number of direct TF participants was limited to a manageable number, and Valley Water extended invitations to representatives of key stakeholder groups.

A charter guided the Stakeholder TF's decision making, process fundamentals, engagement expectations, and lines of communication. Draft work products were provided in advance to enable productive in-person dialogue during Stakeholder TF workshops. Participants were expected to provide feedback on approach, work completed to date, and planned next steps in written comments and during workshops, which have been documented and integrated into the Master Plan to the extent practicable.

3.5.4 Independent Advisory Panel

Valley Water is convening the IAP to review the recommended alternatives and the related regulatory compliance plan. Members of this existing group are nationally recognized reuse experts and will be tapped to guide Valley Water's PR efforts. Valley Water is coordinating with the National Water Research Institute (NWRI) to evaluate the technical, scientific, and regulatory aspects of the feasible Project alternatives, and to solicit IAP feedback for recommended Project alternatives. The IAP's input has been considered in refining project portfolios and elements and the regulatory compliance plan for each.

3.5.5 Regulators

To inform development of the feasible portfolios, Valley Water will hold several meetings with relevant regulators, including DDW and the SFB / Central Coast Regional Water Quality Control Board. This collaborative approach is intended to garner regulators' input, with the objective of gaining support on Project concepts and regulatory compliance plan.

3.5.6 Public

Consistent with Valley Water's past and ongoing reuse efforts, public engagement and support is critical to the Master Plan's success. Valley Water will hold a public meeting to present the draft Master Plan for input and respond to questions.

Section 4: Next Steps

This Project Definition, Roles, and Responsibilities TM provides a basis for the Countywide Water Reuse Master Plan. Additional interim work products will further build on this TM as elements that Valley Water will integrate into the Master Plan, including those described in Section 1.

Going forward, Valley Water will implement the engagement strategy described in Section 3 to collaborate on Master Plan development with the Partner Agencies and external stakeholders.

A

Attachment A: Relevant Planning Studies (Reference List)

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Table A-1. Valley Water-Provided References Used in Project Definition, Roles, and Responsibilities TM	
Reference Title or Description	**Date**
City of Palo Alto, Recycled Water Facility Plan	December 2008
South Bay Water Recycling, Strategic and Master Planning Vol. 1 & Vol. 2	December 2014
City of Sunnyvale, Feasibility Study for Recycled Water Expansion Report	June 2013
City of Sunnyvale, 2015 Urban Water Management Plan	June 2016
South County Recycled Water Master Plan Update Final	May 2016
Valley Water, 2015 Urban Water Management Plan	May 2016
Valley Water, 2012 Water Supply and Infrastructure Master Plan	October 2012
City of Palo Alto, 2015 Urban Water Management Plan	June 2016
City of Palo Alto, Valley Water, City of Mountain View, Final Advanced Water Purification System Feasibility Study	May 2017
San Francisco Bay Regional Water Quality Control Board, NPDES Permit No. CA0037834	2014
City of Mountain View, 2015 Urban Water Management Plan	June 2016
Report to the City Council, City of San José, South Bay Water Recycling: Better Information and Renegotiation of Contractual Obligations Will Increase Transparency and Aid Program Success	March 2016
San José Municipal Water System, 2015 Urban Water Management Plan	June 2016
San Francisco Bay Regional Water Quality Control Board, NPDES Permit No. CA0037842, R2-2014-0034	September 2014
San Jose Water Company, 2015 Urban Water Management Plan	June 2016
City of Gilroy, 2015 Urban Water Management Plan	May 2016
Central Coast Regional Water Quality Control Board, NPDES Permit No: CA0049964, R3-2010-0009	March 2010
City of Sunnyvale, 2016 Recycled Water Annual Report	2016
City of Sunnyvale, Plant Compliance, Annual NPDES Report	2016
San Francisco Regional Water Quality Control Board, NPDES Permit No: CA0037621, R2-2014-0035	November 2014
Valley Water, Groundwater Management Plan 2016	2016
Valley Water, Draft Expedited Purified Water Program Plan	March 2018
Valley Water, One Water Plan	September 2016
San José Green Vision Plan	2007
Valley Water, Water Supply Master Plan 2040	November 2019
City of Palo Alto, Valley Water, City of Mountain View Northwest County Recycled Water Strategic Plan	July 2019

Note: Agreements are listed in Table B-1 and referenced by agreement number.

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Attachment B: Past and Current Agreements List

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Table B-1. Past and Current Agreements between Valley Water and External Partners

Agreement Number	Type	Subject	Partner	Partner Commitment	Valley Water Commitment	Transfer Opportunity	Date Signed	End Date
Palo Alto/Mountain View Agreements								
A3968S	Cost-sharing/funding	AWPF feasibility (consultant support)	Palo Alto	$65,175	$260,700		5/16/2016	12/31/2017[a]
A4040S	Cost-sharing/funding	Northwest County Recycled Water Strategic Plan (consultant support)	Palo Alto	$200,000	$1,800,000		12/15/2016	12/30/2020
A4103M	Water reuse alternatives	Water Reuse Alternatives (WRA) feasibility (investigating supply, sites)	Palo Alto			10 mgd effluent from Palo Alto RWS to Valley Water	8/28/2017	12/31/2020
A4040S	Water reuse alternatives	WRA feasibility (investigating sites)	Mountain View				10/11/2017	12/31/2020
	Cost-sharing and supply commitment	"Local" enhanced recycled water facility construction (~$20M) Supply commitment for Valley Water-owned Regional AWPF	Palo Alto / Mountain View	$1,000,000 (Palo Alto) $3,000,000 (Mountain View)	$16,000,000	9 mgd (minimum annual average flow) effluent from Palo Alto RWS to Valley Water at a cost of ~$100/AF	12/10/2019	12/10/2095
SBWR Agreements								
A2122	Cost-sharing/funding	Development and utilization of NPR (SBWR)	San José		$115/AFY		4/7/1998	6/30/2002[a]
A2517S	Cost-sharing/funding	Silver Creek pipeline (management and operation)	San José	$19,500,000	$6,500,000	5 mgd effluent from SBWR to Valley Water	1/22/2002	1/22/2027
A3339RE	Land use	Right of entry for SVAWPC land	San José				11/13/2009	6/30/2014[a]
A3350S	Supply commitment and land use	SVAWPC (supply transfer and property use)	San José	None (San José owns the property)	$10/year (Valley Water rents the property)	12 mgd secondary effluent from SBWR to Valley Water; 8 mgd from SVAWPC to SBWR	3/2/2010	6/30/2050
A3351S	Cost-sharing/funding	SVAWPC construction	San José	$11M	$36.25M		3/2/2010	6/30/2050
A3596S	Cost-sharing/funding	SBWR improvements/expansions (consultant support)	San José	$1,200,000	$1,200,000		6/28/2012	6/30/2014[a]
A3622S	Operations and maintenance	SVAWPC	San José			1.5 mgd waste stream discharge and 2 mgd RO concentrate from SVAWPC to SJ/SC RWF	12/15/2016	6/30/2050
SCRWA Agreements								
A2280-1	Producer-wholesaler	Supply, Master Plan/CIP preparation (consultant support)	SCRWA	50% of consultant cost	50% of consultant cost		10/5/1999	10/31/2019[a]
A2280-2	Producer-wholesaler	Supply, Master Plan/CIP preparation (consultant support)	SCRWA				10/5/1999	10/31/2019[a]
A2280-3	Producer-wholesaler	Supply, Master Plan/CIP preparation (consultant support)	SCRWA				10/5/1999	10/31/2019[a]
A2280W-4	Producer-wholesaler	Supply, Master Plan/CIP preparation (consultant support)	SCRWA	50% programmatic-level EIR	100% project-level EIR and cost of NPR reservoir		12/12/2006	12/31/2026
A3426S	Cost-sharing/funding	Pipeline construction	SCRWA	$2,151,800	$160,000		12/1/2010	Until complete
A3501X	Infrastructure ownership	Water meter transfer	Gilroy				7/1/2011	Until complete
A3828G	Cost-sharing/funding	Pipeline construction	Gilroy	Unknown	$6,787,888		2/26/2015	Until complete
A3829G	Cost-sharing/funding	Pipeline construction	Gilroy	Unknown	$26,762,678		2/26/2015	Until complete

Table B-1. Past and Current Agreements between Valley Water and External Partners

Agreement Number	Type	Subject	Partner	Partner Commitment	Valley Water Commitment	Transfer Opportunity	Date Signed	End Date
Sunnyvale Agreements								
A3683S	Cost-sharing/funding	Wolfe Road pipeline planning/design (consultant and staff support)	Sunnyvale	$625,000	$625,000		9/24/2013	6/30/2014[a]
A3807A	Cost-sharing/funding	Sunnyvale WPCP AWPF (consultant support)	Sunnyvale		$618,735		12/31/2014	12/31/2018[a]
A3825S	Supply commitment	Recycled water supply to Wolfe Road pipeline	Sunnyvale			1,095 AFY (0.98 mgd) total from Sunnyvale to Valley Water (595 AFY [0.53 mgd] reserved for use in Sunnyvale and 500 AFY [0.45 mgd] for other service areas)	2/6/2015	2/6/2025 (renews every 5 years)
A3822S	Cost-sharing/funding	Wolfe Road pipeline construction – local funding (partially funded by State drought grant, per Agreements A3984R and A3985R)	Sunnyvale	$1,475,000 (initial cost share)	$8,500,000 (initial cost share)		2/6/2015	6 months post-construction
A3984R	Cost-sharing/funding	Wolfe Road pipeline construction – grant reimbursement ($4M in State drought grant funding from ABAG/SFEP[b], passed-through to Valley Water and Sunnyvale as subrecipients with a $6M local cost share, per A3985R)	Sunnyvale	($1,500,000) (reimbursement)	($2,500,000) (reimbursement)		7/20/2015	5/1/2019[a]
A3985R	Cost-sharing/funding	Wolfe Road pipeline construction – local cost share	Sunnyvale	$800,000 (funding match)	$5,200,000 (funding match)		5/17/2016	Until complete
A3821S	Cost-sharing/funding	Wolfe Road pipeline construction	Cal Water	$1,500,000			2/10/2015	2/10/2025
A3823S	Cost-sharing/funding	Wolfe Road pipeline construction	Apple	$4,800,000		0.23 mgd from Sunnyvale to Apple	2/13/2015	3 years post-construction
Sunnyvale Agreements (continued)								
A3824S	Infrastructure ownership	Wolfe Road pipeline crossing construction (Valley Water to own crossing)	Apple	Construction cost			2/13/2015	3 years post-construction
A4076M	Water reuse alternatives	WRA feasibility (cost-sharing and supply)	Sunnyvale		$200,000		6/15/2017	12/31/2020
Other Agreements								
A4064S	Water reuse alternatives	Expedited program (consultant support)	SFPUC/BAWSCA	$37,500	$37,500		3/28/2017	12/31/2018[a]
A3787S	Cost-sharing/funding	Overall recycled water program support (one-time contribution)	Cinnabar Hills Golf Club	$647,520			10/14/2014	Not applicable

a. *Expired.*

b. *SFEP: San Francisco Estuary Partnership.*

Appendix E: Baseline Analysis

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Appendix E-1: Baseline Analysis

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Technical Memorandum

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC Internal)

Contract no.: A4120A

Appendix E-1

Subject: Baseline Analysis

Date: October 4, 2018 (reissued June 30, 2020)

To: Miguel Silva, Valley Water Project Manager

From: Jenny Gain, BC Team Project Manager

Copy to: David Tucker, Valley Water Assistant Project Manager

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Limitations:

This document was prepared solely for Valley Water in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for the partners, regulatory agencies, and stakeholders contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

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List of Abbreviations

ADWF	average dry weather flow
AFY	acre-feet per year
AOP	advanced oxidation process
AWPF	advanced water purification facility
BAF	biologically active filtration
Cal Water	California Water Service Company
CEC	contaminants of emerging concern
CEQA	California Environmental Quality Act
CIP	capital improvement program
CISP	Capital Improvements Strategic Plan
CIWQS	California Integrated Water Quality System
County	Santa Clara County
CT	product of disinfectant residual concentration and contact time
DBP	disinfection by-product
DDW	Division of Drinking Water
DPR	direct potable reuse
EIR	Environmental Impact Report
ESD	Environmental Services Department
FAT	full advanced treatment
gpm	gallon(s) per minute
GWR	groundwater recharge
H_2O_2	hydrogen peroxide
IAP	Independent Advisory Panel
IPR	indirect potable reuse
JRWC	Joint Recycled Water Committee
LF	linear foot/feet
LRV	log removal value
Master Plan	Countywide Water Reuse Master Plan
mg/L	milligram(s) per liter
MF	microfiltration
MG	million gallons
mgd	million gallons per day
MOU	memorandum of understanding
N/A	not applicable
NDMA	N-nitrosodimethylamine
ng/L	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
O&M	operations and maintenance
P3	public-private partnership
PA/MV	Palo Alto/Mountain View
PR	potable reuse
Program Plan	Draft Expedited Purified Water Program Plan
PWWF	peak wet weather flow
RO	reverse osmosis
ROC	reverse osmosis concentrate
RWF	regional wastewater facility
RWQCB	Regional Water Quality Control Board
RWQCP	Regional Water Quality Control Plant
SAT	soil aquifer treatment
SBWR	South Bay Water Recycling
SCRWA	South County Regional Wastewater Authority
SF Bay	San Francisco Bay
SJ/SC RWF	San José-Santa Clara Regional Wastewater Facility
SJW	San Jose Water[1]
SLPS	San Lucar Recycled Water Pump Station
SVAWPC	Silicon Valley Advanced Water Purification Center
TDS	total dissolved solids
TM	Technical Memorandum
TOC	total organic carbon
TPAC	Treatment Plant Advisory Committee
TPS	transmission pump station
UF	ultrafiltration
UV	ultraviolet
UWMP	urban water management plan
Valley Water	Santa Clara Valley Water District
WPCP	water pollution control plant
WSMP	Water Supply Master Plan
WWTP	wastewater treatment plant

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[1] San Jose Water does not use an accent in its name, though City of San José does.

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Executive Summary

The Santa Clara Valley Water District's (Valley Water) Countywide Water Reuse Master Plan (Master Plan) aims to improve water supply reliability through water reuse for Santa Clara County (County) in collaboration with recycled water producers, wholesalers, retailers, users, and other interested parties. The Master Plan will identify the volume of water available for potential potable reuse (PR) development and non-potable reuse (NPR) expansion, the optimal allocation between PR and NPR, options for system integration, recommendations for building on NPR projects and creating new PR projects, and proposals for governance model alternatives, including roles and responsibilities. The Master Plan aligns with Valley Water's Water Supply Master Plan (WSMP; updated in 2019) that describes their strategy for providing a reliable and sustainable water supply in a cost-effective manner.

Before exploring conceptual and feasible water reuse alternatives, Valley Water gathered up-to-date information for recycled water facilities in the County. This Baseline Analysis presents a review of existing information and analyses to establish existing conditions for the recycled water facilities and distribution systems in the County. This evaluation also includes a preliminary assessment of the volume of water available for reuse, the potential NPR/PR split, and a summary of potential infrastructure improvements. The Baseline Analysis is intended to inform development of conceptual alternatives and, ultimately, the final Master Plan.

Existing Systems

Four recycled water systems in the County produce water for NPR: (1) Palo Alto/Mountain View (PA/MV), (2) Sunnyvale, (3) South Bay Water Recycling (SBWR), and (4) South County Regional Wastewater Authority (SCRWA). The Silicon Valley Advanced Water Purification Center (SVAWPC) further treats some of the recycled water for SBWR.

Palo Alto/Mountain View

The Palo Alto Regional Water Quality Control Plant (RWQCP) produces recycled water for customers in Palo Alto and the North Bayshore area of Mountain View. The RWQCP can currently produce up to 4.5 million gallons per day (mgd) of recycled water, though much of its equipment requires rehabilitation or replacement. PA/MV also plans to extend its recycled water distribution system. The most notable challenges for the PA/MV recycled water system are high salinity in the source water and insufficient storage.

Valley Water and the City of Palo Alto entered into a memorandum of understanding (MOU) in 2017 to assess the feasibility of developing water reuse alternatives. This MOU was replaced by a full Agreement between Palo Alto, Mountain View, and Valley Water, effective December 10, 2019. Valley Water and Palo Alto continue to coordinate efforts through a Joint Recycled Water Committee.

Sunnyvale

The Donald M. Somers Water Pollution Control Plant (WPCP) supplies the Sunnyvale recycled water system. The City of Sunnyvale is currently upgrading the WPCP, which will increase recycled water production capacity to 4 mgd. Overall, the Sunnyvale recycled water system is very reliable, with potable water backups at the WPCP pump station and the San Lucar tank, and the ability to feed the entire system from the San Lucar Recycled Water Pump Station.

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The City of Sunnyvale is the producer, wholesaler, and retailer for recycled water, except for service to the Wolfe Road pipeline. Along the Wolfe Road pipeline, Valley Water is the wholesaler, and California Water Service Company is the retailer. In 2017, Valley Water and City of Sunnyvale entered into an MOU to collectively study the feasibility of various recycled water system upgrades, including construction of an advanced water purification facility (AWPF) and potential interties between Sunnyvale, PA/MV, and SBWR systems.

SBWR

SBWR delivers recycled water produced at the San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF) to customers in the cities of San José, Santa Clara, and Milpitas. Recycled water production is limited to 38 mgd by the granular media filters. Up to 8 mgd of this supply can originate from SVAWPC.

A 2010 Condition Assessment concluded that the system is generally well-maintained and in good condition, but some facilities, including communications, valves, and transmission pumps and electrical components, are nearing the end of their useful lives. SJ/SC RWF is implementing a $2 billion capital improvement program over the next 30 years to address these needs.

In 2010, Valley Water and the City of San José agreed to formally coordinate recycled water efforts by creating a Joint Recycled Water Policy Advisory Committee. This Committee advises the Valley Water Board and the City Council of the City of San José on policy matters relating to the production, distribution, and use of recycled water.

SVAWPC

Valley Water's SVAWPC opened in 2014 to reduce the salinity of SBWR recycled water and demonstrate advanced treatment technology. SVAWPC can produce up to 8 mgd and employs many of the treatment processes needed for PR. SVAWPC applies microfiltration (MF), reverse osmosis (RO), and ultraviolet (UV) light disinfection to a side stream of regional wastewater facility water to improve the quality of SBWR water.

SCRWA

The SCRWA Wastewater Treatment Plant (WWTP) was built in 1990 to serve the cities of Gilroy and Morgan Hill and can currently produce up to 8 mgd of recycled water. SCRWA and Valley Water executed a producer-wholesaler agreement and a wholesaler-retailer agreement in 1999 for a 20-year term. Following this term, the agreements are automatically renewed and extended annually for 1 year unless terminated by the parties.

The City of Gilroy, on behalf of Valley Water, operates and maintains the distribution pump station and tank. Valley Water maintains distribution pipelines and wholesales recycled water. Redundancy from system storage protects against treatment disruptions, and though pumping is vulnerable there are plans to add a new pump. Planned long-term capital improvements also include adding capacity to the WWTP.

Potable Reuse Research and Planning

Valley Water has undertaken several research efforts to evaluate indirect potable reuse (IPR) through groundwater recharge (GWR) and direct potable reuse (DPR), with the following goals:

- Demonstrate compliance with the regulatory requirements for GWR at both pilot and full scale
- Evaluate alternatives to upgrade the UV disinfection system to an advanced oxidation process (AOP)
- Evaluate ozone with biologically active filtration to spread GWR and in DPR
- Educate stakeholders on SVAWPC's ability to create high-quality water for PR

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Valley Water's Expedited Purified Water Program evaluated several options for PR. Through this effort, Valley Water identified a groundwater spreading project as its recommended first phase, which includes delivering 24 mgd of full advanced treatment (i.e., MF, RO, and an AOP) water from an expanded SVAWPC to the Los Gatos Ponds.

Expanded Reuse Opportunities and Considerations

Valley Water requested data from the Palo Alto RWQCP, Sunnyvale WPCP, SJ/SC RWF, and SCRWA WWTP to establish current conditions and projected future conditions to determine the volume available for NPR and PR. Using plant influent and outflow streams, a flow balance was created to calculate the remaining effluent available (i.e., plant influent minus losses, environmental flows, and NPR demands).

In this analysis, the remaining effluent available for discharge, blending, or additional reuse (above and beyond the 2015 Urban Water Management Plan [UWMP] recycled water demand projections) was estimated. Annual averages are summarized in Table ES-1 for the years 2025 and 2035. These flows may not be available year-round, particularly in the summer months. Furthermore, some agencies have contractual agreements restricting the use of certain flows, and making these flows available for Valley Water would require new agreements. For this analysis, it was assumed that NPR demands will increase per the future values estimated in the 2015 UWMPs, and any remaining effluent (as shown in Table ES-1) will be available for discharge, blending, or as source water for PR (i.e., feed water for an AWPF). Some of this flow may be rejected in the reverse osmosis concentrate (ROC) stream, or used to dilute the ROC for discharge, depending on the findings of Valley Water's ROC management study. Flow estimates are preliminary and may be refined as more recent data and/or projections become available.

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Table ES-1. Preliminary Estimates of Effluent Remaining for Discharge, Blending, or Additional Reuse (Beyond Existing Plans for NPR) in 2025 and 2035

Partner Agency	Available Influent, mgd (AFY)[a]	NPR Demands, mgd (AFY)	Losses/Environmental Flows, mgd (AFY)	Remaining Effluent, mgd (AFY)[b]	Current Contractual Obligation[c]
2025					
Palo Alto RWQCP	21.0 (23,400)	2.5 (2,800)	1.3-3.3[d] (1,500–3,700)	15.2-17.2 (16,900–19,200)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale WPCP	14.6 (16,300)	1.4 (1,600)	1.4-4.0[e] (1,600–4,500)	9.2-11.8 (10,300-13,200)	See footnote (f)
SJ/SC RWF	103.2 (115,600)	18.1 (20,300)	0	85.1 (95,300)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA WWTP	6.5 (7,300)	2.8 (3,100)	0	3.7 (4,200)	N/A
Total, 2025 [g]	**145.3** **(162,700)**	**24.8** **(27,900)**	**2.7-7.3** **(3,000-8,200)**	**113.2–117.8** **(126,700-131,800)**	
2035					
Palo Alto RWQCP	22.1 (24,700)	2.5 (2,800)	1.3-3.3[d] (1,500–3,700)	16.3-18.3 (18,200–20,400)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale WPCP	17.3 (19,400)	1.5 (1,700)	1.4-4.0[e] 1,600–4,500	11.8-14.4 (13,200-16,100)	See footnote (f)
SJ/SC RWF	107.4 (120,200)	21.5 (24,200)	0	85.9 (96,000)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA WWTP	6.5 (7,300)	3.3 (3,700)	0	3.2 (3,600)	N/A
Total, 2035 [g]	**153.3** **(171,600)**	**28.8** **(32,400)**	**2.7-7.3** **(3,000-8,200)**	**117.2-121.8** **(131,000-136,200)**	

a. Estimated based on 2015-2017 actuals and projected rate of increase from previous planning studies.

b. Calculated as available influent less the sum of 2015 UWMP NPR demand estimates, environmental flows, and other losses (such as in-plant process water losses).

c. Projected NPR demands do not fully capture potential allocations per contractual agreements. New agreements may be needed to access portions of available effluent for additional reuse. Governance considerations will be further evaluated as the Master Plan progresses.

d. Range reflects flow to Renzel Marsh currently included in the NPDES permit (1 mgd) and a high estimate (3 mgd), in case of a future expansion, along with an estimated 0.3-mgd loss of effluent used for in-plant processes (per Palo Alto's 2015 UWMP).

e. Range reflects current evaporation rates and higher estimate reserved for evaporation, capping, and other losses.

f. Per agreement between Sunnyvale and Valley Water, Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits. Valley Water and Sunnyvale meet annually to discuss the anticipated quantity of recycled water to be delivered through the Wolfe Road Pipeline to Valley Water customers.

g. Difference due to rounding.

AFY = acre-feet per year; N/A = not applicable

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To expand capacity and reliability of the County's existing recycled water systems, several projects are under consideration, including interties for existing NPR, connections between potential PR systems, and major CIP projects. Factors that must be considered when expanding water reuse include public perception and supply reliability.

Gap Analysis

Valley Water has undertaken multiple efforts to demonstrate the effectiveness of GWR for IPR and is also exploring DPR as a water supply option; however, there are several gaps that require further clarification or study. Table ES-2 summarizes recommendations for future GWR and DPR efforts.

Table ES-2. PR Gap Analysis Recommendations

Consideration	Recommendation	
	GWR	DPR
Treatment	• Additional testing to increase RO credits • Testing to evaluate UV/AOP (underway) • Additional testing if Valley Water decides to pursue non-RO-based groundwater spreading options	• Additional testing of ozone/BAF to improve dosing control and assess benefits for downstream processes and ROC management • Additional testing to increase RO credits • Testing to evaluate UV/AOP (underway) • Demonstration testing of DPR treatment train to gain experience with integration of high-frequency data collection
Source water quality	• Characterize potential source waters for key constituents (e.g. N-nitrosodimethylamine [NDMA])	• Consider quality of feedwater needed for DPR (e.g. nitrified/denitrified, tertiary filtered) • Consider pathogen monitoring study at WWTP to obtain removal credits
Regulations	• No regulatory gaps: GWR regulations finalized in 2014	• DPR regulations not anticipated until 2023 • Consider potential additional requirements, e.g. treatment, monitoring, operations
Source control	• Begin coordination with wastewater provider to broaden source control program	
Groundwater characterization	• Characterize groundwater basin retention times through tracer studies • Characterize availability of diluent water for tertiary spreading • Continue characterizing water quality of existing basins	N/A
Environmental discharge	• Evaluate compliance with Salt and Nutrient Management Plans and antidegradation regulations • Likely to be more challenging with GWR via tertiary spreading	N/A
Source water availability	• Secure institutional agreements with recycled water producers	
ROC management	• Continue evaluating ROC management strategies • Coordinate with wastewater agencies, regulatory agencies, and interested stakeholders to implement ROC management	
Demand (water supply needs)	• Valley Water plans to complete the WSMP in coordination with this Master Plan	
Utilization rate	• Valley Water plans to complete the WSMP in coordination with this Master Plan	

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Section 1: Existing Reuse Systems in Santa Clara County

Santa Clara County (County) has four recycled water systems that deliver water for non-potable reuse (NPR): (1) Palo Alto/Mountain View (PA/MV), (2) Sunnyvale, (3) South Bay Water Recycling (SBWR), and (4) South County Regional Wastewater Authority (SCRWA), referred to collectively as the Countywide Water Reuse Master Plan Partner Agencies. The Santa Clara Valley Water District's (Valley Water) Silicon Valley Advanced Water Purification Center (SVAWPC) opened in 2014 to reduce the salinity of SBWR recycled water and demonstrate advanced treatment technology.

This section provides an overview of each system's service area, governance structure, and financial status, and summarizes current and projected recycled water demands, treatment plant capacity, and system deficiencies.

1.1 Service Areas

This section describes each recycled water system's current service area, along with long-term expansion plans. Figure 1-1 shows the locations of treatment plants and pipelines for each system.

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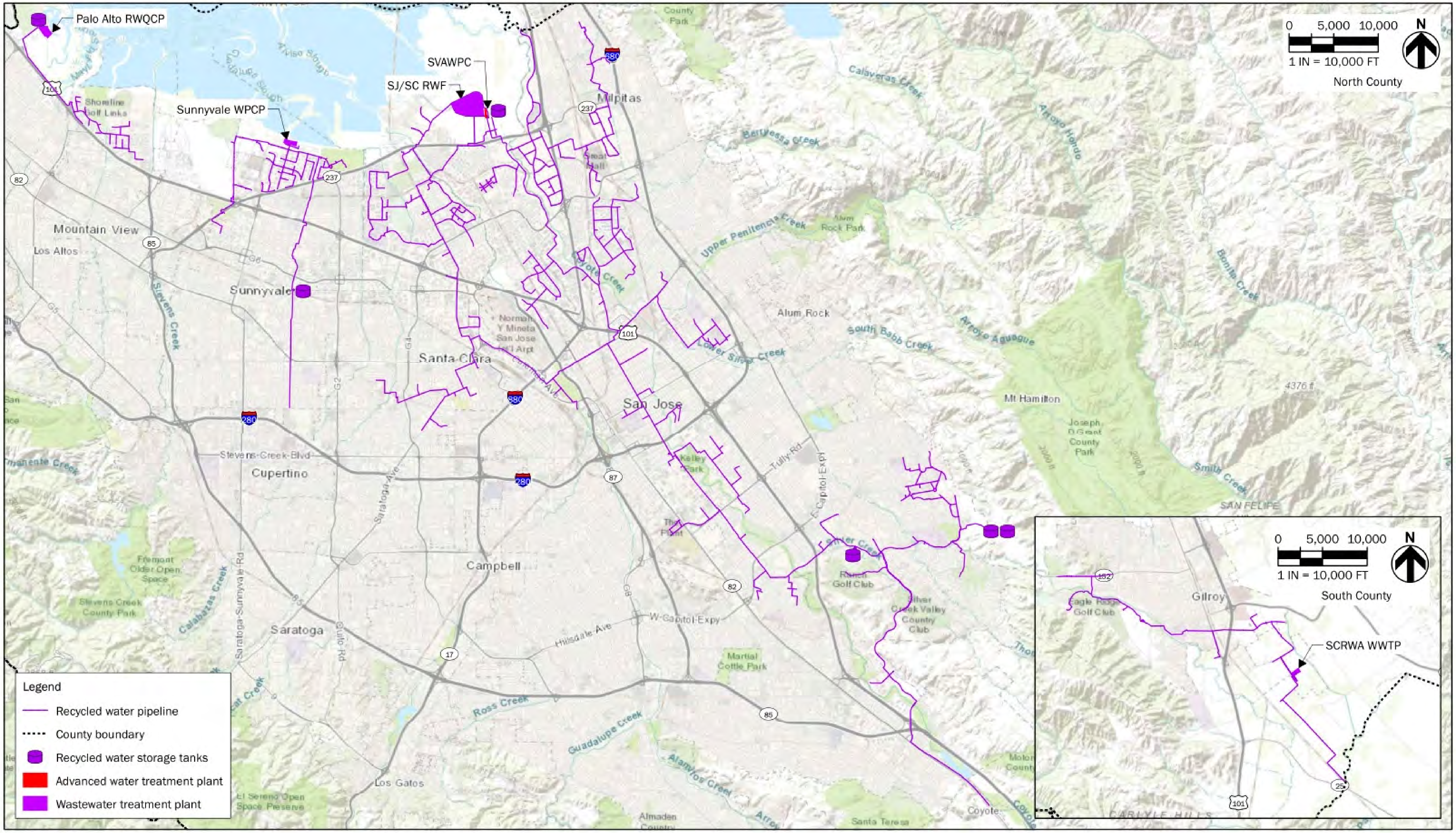

Figure 1-1. County recycled water distribution systems

Brown AND Caldwell

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1.1.1 Palo Alto/Mountain View

The Palo Alto Regional Water Quality Control Plant (RWQCP) treats wastewater for the cities of Palo Alto, Mountain View, Los Altos, and Los Altos Hills; East Palo Alto Sanitary District; and Stanford University. Owned and operated by the City of Palo Alto, the RWQCP produces recycled water for Palo Alto customers near the plant and the North Bayshore area of Mountain View.

PA/MV has planned recycled water distribution system extensions. The Palo Alto Recycled Water project plans to construct 11 miles of pipeline to serve approximately 50 locations within South Palo Alto, including Alta Mesa Memorial Park. The City of Palo Alto envisions that future extensions of this pipeline may provide connectivity to future Mountain View, Los Altos, and Los Altos Hills NPR project extensions. The City of Mountain View's 2014 Recycled Water Feasibility Study identified several options for a multi-phase expansion called the Whisman School Park/Central Expressway Alignment. This extension includes approximately 36,000 linear feet (LF) of new pipeline throughout the City of Mountain View.

Additionally, Palo Alto is planning construction of a 1.25 to 2.5 million gallons per day (mgd) advanced water purification facility (AWPF) near the Palo Alto RWQCP to blend purified water with recycled water to reduce salinity.

1.1.2 Sunnyvale

The Donald M. Somers Water Pollution Control Plant (WPCP) supplies the Sunnyvale recycled water system. The WPCP is owned and operated by the City of Sunnyvale. The recycled water distribution network mainly serves customers north of Highway 237, though a recently installed main on Wolfe Road extends south to serve the new Apple Campus in Cupertino.

In June 2013, the City of Sunnyvale finalized a Feasibility Study for Recycled Water Expansion Report that identified new recycled water alignments and pumping/storage upgrades to meet near-term demands (City of Sunnyvale 2013b). Including the completed Wolfe Road recycled water pipeline, new alignments total 97,600 LF of new pipe and include extensions from existing and proposed pipes and a new main loop connecting to the Wolfe Road main.

Valley Water oversized the Wolfe Road recycled water pipeline for NPR within Sunnyvale and Cupertino. The additional capacity considers potential future conversion of this pipeline into a purified water pipeline for groundwater recharge (GWR).

1.1.3 San José-Santa Clara Regional Wastewater Facility/South Bay Water Recycling

The San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF) treats wastewater from the cities of San José, Santa Clara, Milpitas, Campbell, Cupertino, Los Gatos, Monte Sereno, and Saratoga. It is co-owned by the City of San José and the City of Santa Clara but operated solely by the City of San José as the administrative agency. SBWR delivers recycled water produced at the SJ/SC RWF to customers in the cities of San José, Santa Clara, and Milpitas.

Future non-potable recycled water expansion is focused in Milpitas and central and southern San José. For additional information, refer to Section 3.2.2.

1.1.4 Silicon Valley Advanced Water Purification Center

Valley Water owns and operates the SVAWPC located on Zanker Road, just across the street from the SJ/SC RWF in San José. SVAWPC was developed to further enhance the quality of SBWR recycled water. Because the facility employs many of the treatment processes needed for PR, it has also been used to evaluate PR as a future water supply option.

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1.1.5 South County Regional Wastewater Authority

The South County Regional Wastewater Treatment and Reclamation Facility supplies recycled water customers in Gilroy. While the wastewater treatment plant (WWTP) treats wastewater from the cities of Gilroy and Morgan Hill, the recycled water pipeline extends only to Gilroy. One branch runs north and west to Eagle Ridge Golf Course; the southern branch delivers recycled water to two farms along Sheldon Avenue.

Valley Water is installing an additional 14,500-LF NPR pipeline in western Gilroy, coordinated in part with new developments planned in Gilroy.

1.2 Governance

This section reviews the governance framework for each recycled water system, including managing treatment/production and producer/wholesaler/retailer relationships.

1.2.1 Palo Alto/Mountain View

The City of Palo Alto Department of Public Works Environmental Services Division operates and maintains the RWQCP. The City of Palo Alto is the producer and wholesaler of recycled water for the PA/MV system, which treats wastewater from the communities of Los Altos, Los Altos Hills, Mountain View, and Palo Alto; Stanford University; and the East Palo Alto Sanitary District. Palo Alto and Mountain View each retail recycled water to customers within their city limits.

Valley Water and the City of Palo Alto entered into a Memorandum of Understanding (MOU) in 2017 to coordinate their efforts to study multiple items, including:

- Evaluating water reuse alternatives, including opportunities to transfer up to 10 mgd of RWQCP effluent, for expansion of recycled and purified water
- Evaluating the feasibility of constructing and operating an AWPF
- Evaluating water recharge and reuse alternatives identified in the Northwest County Recycled Water Strategic Plan
- Exploring future development of the PA/MV NPR system, including Valley Water's potential governance role
- Developing a residuals management plan, permitting plan, and water quality monitoring plan
- Evaluating land options for locating an AWPF in Palo Alto

On December 10, 2019, Palo Alto, Mountain View, and Valley Water executed a full agreement, replacing the 2017 MOU. Valley Water and the City of Palo Alto are continuing to coordinate through the City of Palo Alto and Valley Water Elected Officials Joint Recycled Water Committee (JRWC) to provide updates on recycled water opportunities, advance common interests, and establish a collaborative process to facilitate policy discussion and share technical information on recycled water issues. JRWC comprises three Valley Water board members, two City of Palo Alto council members, one City of Mountain View council member, and one East Palo Alto council member. Formal actions recommended by JRWC must still go back to each member agency for formal approval. A Technical Advisory Committee was also created that consists of Valley Water and City of Palo Alto staff to review work products and make recommendations to JRWC.

1.2.2 Sunnyvale

The City of Sunnyvale Environmental Services Department (ESD) manages the Sunnyvale recycled water program, which consists of production/operation, distribution, permitting, and monitoring. Within ESD, the WPCP Division oversees production and pump station operation, while the Water and Sewer Division manages distribution and user permitting. Recycled water quality monitoring is handled by the Regulatory

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Programs Division. The City of Sunnyvale is the producer, wholesaler, and retailer for recycled water, except for service to the Wolfe Road pipeline. Along the Wolfe Road pipeline, Valley Water is the wholesaler, and California Water Service Company (Cal Water) is the retailer.

Since 2014, Valley Water and the City of Sunnyvale have entered into multiple agreements to collectively evaluate WWTP layouts and configurations that may provide Valley Water with treated wastewater for future PR. In 2017, Valley Water and the City of Sunnyvale entered into an MOU (that extends through December 31, 2020) to collectively study the feasibility of:

- Evaluating alternative WWTP layouts for the Sunnyvale WPCP upgrade
- Making treated effluent available to Valley Water at a site near the Sunnyvale WPCP (e.g., Recycle Hill)
- Evaluating the construction of an AWPF at the Sunnyvale WPCP
- Constructing a pipeline to convey treated wastewater from the Sunnyvale WPCP to an expanded SVAWPC in San José
- Constructing interties between the Sunnyvale and SBWR recycled water distribution systems
- Constructing an AWPF to manage Sunnyvale recycled water salinity
- Constructing an intertie to convey treated wastewater from the Palo Alto RWQCP for advanced treatment at either the Sunnyvale RWQCP or the expanded SVAWPC
- Assessing the feasibility of providing Valley Water with 5 mgd of effluent by the year 2020, and an additional 5 mgd of effluent after 2020 (10 mgd total)
- Developing a residuals management plan, permitting plan, and water quality monitoring plan

Cost-sharing activities were also allocated to Valley Water and City of Sunnyvale for this work based on the type of feasibility study or work to be performed. They are coordinating efforts through the City of Sunnyvale and Valley Water Elected Officials JRWC to provide updates on recycled water opportunities, advance common interests, and establish a collaborative process to facilitate policy discussion and share technical information on recycled water issues. Formal actions recommended by the JRWC must still go to back to each member agency for formal approval. This joint committee comprises three Valley Water board members and two City of Sunnyvale council members. A Technical Advisory Committee, consisting of Valley Water and City of Sunnyvale staff, has also been created to review work products and make recommendations to Valley Water and City of Sunnyvale.

This Master Plan is expected to help inform the governance, terms, and contents of future agreements between Valley Water and City of Sunnyvale.

1.2.3 San José-Santa Clara Regional Wastewater Facility/South Bay Water Recycling

Under the City of San José's ESD, SBWR's policies and budget are determined by the Treatment Plant Advisory Committee (TPAC) and San José's City Council. The TPAC is an advisory group to the City Councils of San José and Santa Clara and was created in 1959 by the Sewage Treatment Plant Agreement between San José and Santa Clara. The City of San José, in partnership with the City of Santa Clara, jointly owns, operates, maintains, repairs, and coordinates improvements to the SJ/SC RWF under this master agreement. Additionally, they jointly develop and administer amendments to contract and agreements, including interests in SJ/SC RWF to anyone other than the City of San José and the City of Santa Clara. While seven cities and sanitary/sanitation districts discharge wastewater to SJ/SC RWF under a series of additional master agreements, the City of San José is the administering agency, and its City Council is the final decision-making body.

Spanning multiple cities, the SBWR system involves more stakeholders and thus a more complex governance structure. Tertiary treated recycled water produced at the regional wastewater facility (RWF) is blended with advanced treated water produced at Valley Water's SVAWPC. SBWR delivers this blended

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recycled water to the SBWR distribution system and wholesales it to four retailers: (1) the City of Milpitas, (2) City of Santa Clara, (3) San José Municipal Water System, and (4) San Jose Water (SJW). Two other retailers, Cal Water and Great Oaks Water Company, are located within the SBWR service area but do not distribute SBWR recycled water.

The Ground Lease and Property Use Agreement between the City of San José and Valley Water allowed Valley Water to lease from the City of San José the premises and ancillary property where the SVAWPC is located. The lease extends through June 30, 2050, and requires Valley Water to make an annual payment to the City of San José to use the premises and ancillary property.

The Recycled Water Facilities and Program Integration Agreement created a mechanism for Valley Water and the City of San José to formally coordinate on financially supporting the production and use of recycled water. Terms of this agreement, which also extends through June 30, 2050, include:

- Creating the Joint Recycled Water Policy Advisory Committee (City of San José/Valley Water/City of Santa Clara TPAC) made up of three Valley Water Board members, one City of San José City Council member, and one City of Santa Clara Council member. The remaining member can be from any city or agency with voting membership in the TPAC. Similar to the JWRC, this committee tenders its advice to the Valley Water Board and each member agency's City Councils for formal approval of official actions.
- Creating a Technical Working Group that includes staff from Valley Water and the City of San José
- Approving budgets for SBWR and SVAWPC
- Operational Support Payments associated with profits/loss for the operating budgets of SBWR and the SVAWPC
- Constructing the SVAWPC
- Limiting the export of effluent outside the County by either Valley Water or City of San José through July 1, 2020. After 2020, export is allowed only if the demand for in-county use of recycled water is less than the available supply.

Valley Water and the City of San José executed the Operation and Maintenance Agreement for SVAWPC in October 2012. The agreement provides Valley Water with the rights to:

- Accept up to 12 mgd of secondary effluent from the SJ/SC RWF
- Operate, maintain, and monitor SVAWPC to produce purified water in accordance with permits obtained from Division of Drinking Water (DDW)
- Blend purified water with recycled water produced by the RWF
- Discharge up to 2 mgd of reverse osmosis concentrate (ROC) from SVAWPC to the RWF chlorine contact tanks

1.2.4 South County Regional Wastewater Authority

SCRWA is a joint powers authority created by the cities of Gilroy and Morgan Hill to manage wastewater treatment. An agreement among SCRWA, Valley Water, and the cities of Gilroy and Morgan Hill establishes SCRWA as the NPR producer, Valley Water as the wholesaler, and the cities of Gilroy and Morgan Hill as the retailers. The City of Gilroy currently retails recycled water. Recycled water facilities are not yet within Morgan Hill. Valley Water can sell recycled water directly to end users outside the City of Gilroy's service area.

The producer-wholesaler agreement between SCRWA and Valley Water was originally executed in 1999 for a 20-year term (i.e., to 2019). In 2006, SCRWA and Valley Water signed an amended agreement for another 20-year term. Following this term (i.e., after 2026), the agreement is automatically renewed and extended annually for 1 year unless terminated by the parties. Terms of the 2006 agreement included:

- Commitment by Valley Water to make "best efforts" to develop and encourage the use of recycled water.

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- Valley Water has the rights to use and first right of refusal for recycled water produced at the SCRWA WWTP, which is to be delivered at the point of connection with pressures between 80 and 110 pounds per square inch.
- Updating, at 5-year intervals, the recycled water master plan to design and construct recycled water distribution facilities. The plan must also include a phased capital improvement program (CIP) that includes WWTP improvements and distribution system extensions.
- SCRWA is responsible for facilities upstream of the point of connection at which water is delivered to Valley Water. Valley Water is responsible for facilities downstream of the connection point. Each party owns, operates, and maintains its facilities.

Valley Water and the City of Gilroy also executed a wholesaler-retailer agreement for NPR supply within the City of Gilroy. Originally executed in 1999 for a 20-year term, the agreement is also automatically renewed and extended annually for 1 year unless terminated by the parties.

1.3 Finances

This section examines the financial picture for each recycled water system, including retailer recycled water rates, major financial obligations, and operating requirements.

1.3.1 Water Rates

To encourage recycled water use, retailers typically set NPR rates lower than potable water rates. Table 1-1 compares the potable water and recycled water consumption rates for each retailer in the County that sells both.

Table 1-1. Water Consumption Rates for Potable and Recycled Water

Retailer	Unit Cost/100 Cubic Feet[a, b]		Source
	Potable Water	Non-Potable Recycled Water	
City of Palo Alto[c]	$9.33	Not applicable	City of Palo Alto Utility Rate Schedule W-7 (effective 7/1/18)
City of Mountain View[d]	$6.80	$3.75	City of Mountain View Water Rates website (effective 7/1/18)
City of Sunnyvale	$4.85	$4.37	City of Sunnyvale Fiscal Year 2018/19 Utility Fee Schedule
Cal Water	$5.7379	$5.7379	Schedule LS-1-NR and LS-6, Los Altos Tariff Area (effective 7/1/18)
City of Milpitas[e]	$5.13	$2.78	City of Milpitas Public Works Department website, "Service Rates and Fees"
City of Santa Clara[f]	$5.98	$3.26–$3.58	City of Santa Clara Water & Sewer Utilities website, "Water, Sewer and Recycled Water Rates" (effective 7/1/18)
San José Municipal Water System[g]	$2.04–$4.98	$2.711–$3.370	City of San José Water Utilities website, "Drinking Water Rates and Recycled Water Rates" (effective 7/1/18)
SJW	$4.72750	$4.2669	SJW Billing Schedules (effective 8/25/18)
City of Gilroy[h]	$2.82–$3.66	$0.69	City of Gilroy Water Fee Schedule rev. 7/1/18 and 2015 South County Recycled Water Master Plan Update, Appendix K (2014–15 rate)

a. *All charges are presented as generally for commercial users of water for irrigation and non-potable use.*
b. *Rates change regularly and include/exclude various other factors such as meter charges, taxes, and other fees.*
c. *Current recycled water users in the City of Palo Alto are City facilities and thus not charged for recycled water. Per the City of Palo Alto's municipal code (16.12.060), a 50 percent surcharge would be added to potable water rates if a customer irrigates with potable water when recycled water is available.*
d. *The City of Mountain View has uniform rates for all businesses.*
e. *In addition to usage, the City of Milpitas charges each customer $1.30 as a bi-monthly capital surcharge.*
f. *The City of Santa Clara charges a lower rate for industrial use than irrigation use.*
g. *San José Municipal Water potable water rates are based on location and zone. Recycled water rates are based on type of use.*
h. *The City of Gilroy charges a lower rate for agricultural use than municipal and industrial use.*

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1.3.2 Financial Obligations/Operating Requirements

The following discussion of financial obligations and operating requirements is organized based on recycled water system and, if applicable, agreements with others.

Palo Alto/Mountain View. The cities of Palo Alto and Mountain View entered into an agreement in 2007 regarding the use of recycled water from the Palo Alto RWQCP and other related provisions. The two parties agreed to share the facility design and construction costs to bring recycled water from the Palo Alto RWQCP to Mountain View.

As part of the agreement, the cities own the recycled water distribution systems within their respective service areas. Both parties have the right to approve or disapprove of water transfers from infrastructure within their service area and extending infrastructure within their service area, so long as the City of Mountain View does not exceed its allocated recycled water supply of 3 mgd (i.e., its maximum delivery rate). This agreement was amended in 2017, extending the agreement term to 2060.

Palo Alto/Mountain View – Valley Water. Palo Alto, Mountain View, and Valley Water executed an agreement effective December 10, 2019. The agreement defines a plan for Valley Water to provide $16 million toward the construction of the enhanced recycled water facility or “Local Plant” operated by Palo Alto or other possible alternatives to the Local Plant that still benefit RWQCP Partners; and effluent transfer volumes and payment for effluent used for a Valley Water-owned regional AWPF or “Regional Plant” located in Palo Alto or elsewhere in Santa Clara County.

Sunnyvale. The City of Sunnyvale does not have any known financial obligations for constructing its recycled water distribution system.

Sunnyvale – Valley Water. Valley Water and the City of Sunnyvale entered into agreements to construct the Wolfe Road Recycled Water project and guarantee its recycled water supply. Valley Water received the right to own the project facilities, wholesale recycled water from those facilities, and receive up to 1,095 acre-feet per year (AFY) of recycled water to resale, of which up to 500 AFY can be resold outside of Sunnyvale. The City of Sunnyvale operates and maintains the project facilities, including the San Lucar Recycled Water Pump Station (SLPS), but Valley Water owns those facilities. This agreement remains in force for a 10-year period beginning in 2014, then automatically renews for a 5-year term thereafter.

Sunnyvale – Cal Water. Cal Water owns, operates, and maintains the portions of the Sunnyvale distribution system that it constructed. There are no ongoing financial obligations associated with these projects, as they have been funded by implementing General Rate Cases adopted by the California Public Utilities Commission. Cal Water is responsible for all capital and operations and maintenance (O&M) costs associated with operating its facilities, as detailed in the wholesaler-retailer agreement between Cal Water and Valley Water.

SJ/SC RWF/SBWR. The March 2016 Report 16-05 titled South Bay Water Recycling: Better Information and Renegotiation of Contractual Obligations will Increase Transparency and Aid Program Success summarized the bonds and annual debt service obligations of the SBWR distribution system (Erickson 2016).

Sanitary sewer ratepayers from San José, Santa Clara, and all the tributary agencies (City of Milpitas, Cupertino Sanitary District, West Valley Sanitation District, County Sanitation District 2-3, and the Burbank Sanitary District) have paid for SBWR initial capital costs through sewer revenue bonds, loans, and cash contributions. Currently, there are two active bond series (2005A and 2009A) issued by the San José-Santa Clara Clean Water Financing Authority, and a loan from the State Revolving Loan Fund. Through fiscal year 2020–21, the cities of San José and Santa Clara and the tributary agencies are obligated to pay between $5M and $9M per year from wastewater facility revenues.

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SBWR is responsible for operating the recycled water production facilities that it owns and conveying recycled water to each of the four recycled water retailers. Recycled water is delivered to pipelines in each retailer's service area and turnouts to retailer-owned recycled water pipelines. Each retailer operates and maintains the distribution facilities in its service area, and SBWR reimburses the San José Municipal Water System, the City of Santa Clara, and the City of Milpitas for O&M costs. SJW also owns, operates, and maintains the recycled water distribution facilities that it owns. Wholesaler-retailer agreements also specify the quantities of recycled water that are available, as well as delivery limitations. SBWR is also responsible for recycled water quality and all regulatory permitting.

SBWR – Valley Water. As part of the agreement executed on January 22, 2002 between the City of San José and Valley Water regarding managing and operating the SBWR system, Valley Water paid to upsize the 30-inch-diameter Silver Creek Pipeline to bring recycled water to Coyote Valley and the Metcalf Energy Center. In exchange for paying for the upsized pipeline, Valley Water received the rights to use and/or wholesale at a minimum 5 mgd of recycled water (approximately 3,500 gallons per minute [gpm]) from this pipeline. Valley Water has been considering opportunities to use this supply for a potential indirect potable reuse (IPR) project. The term of this agreement remains in effect through 2027.

SBWR and Valley Water also executed the Recycled Water Facilities and Programs Integration Agreement in 2010. Among its financial obligations, CSJ and Valley Water shall consider any recommendation tendered by the Recycled Water Policy Advisory Committee on their proposed budgets to maintain, expand, replace, improve and operate SBWR and SVAWPC. While SVAWPC is operational, the agreement also includes operational support payments relating to the net operating cost of SBWR and SVAWPC. The term of this agreement runs through June 30, 2050.

SBWR – SJW. SJW owns, operates, and maintains the portions of the SBWR distribution system that it has constructed. There are no ongoing financial obligations as a result of these projects, as they were funded through implementing General Rate Cases adopted by the California Public Utilities Commission. SJW is responsible for all capital and O&M costs associated with operating its facilities, as detailed in the two wholesaler-retailer agreement amendments between the City of San José and SJW.

SCRWA – Valley Water. In 1999, Valley Water, the cities of Gilroy and Morgan Hill, and SCRWA entered partnership agreements with SCRWA as the producer, Valley Water as wholesaler, and the cities of Gilroy and Morgan Hill as retailers to develop a recycled water project. Since that time, Valley Water and SCRWA have completed several improvements to the distribution system and SCRWA treatment plant to increase recycled water use. A portion of those improvements were funded by federal grants, with the remainder covered by Valley Water and SCRWA.

The existing South County recycled water distribution system is operated by Valley Water (in coordination with the City of Gilroy) and has no known financial obligations that impact future recycled water expansion within this service area.

1.4 Recycled Water Demands

Recycled water demands have steadily increased over the years until the most recent drought period of 2013–2016. Since then, recycled water demands have slightly decreased. Recycled water demands are expected to stay steady or slightly increase as additional customers receive recycled water by retrofit, redevelopment, or construction of new infrastructure.

Current (2015) and projected (2020–2040) demands were adapted from each retailer's 2015 Urban Water Management Plan (UWMP) within each recycled water retailer's service area. For the PA/MV, Sunnyvale, and SCRWA systems, recycled water demands are projected to stabilize by 2030, while SBWR demands are projected to steadily rise through 2040. Table 1-2 summarizes current and projected recycled water

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demands from the 2015 UWMPs (potable and non-potable) for each retailer, with subtotals for each producer and a countywide total. Note–some Partner Agencies are in the process of updating their demand projections (to be incorporated into the Master Plan if and when available).

Table 1-2. Current and Projected Recycled Water Demands from 2015 UWMPs

Producer	Retailer	Demand (AFY)[a]					
		2015	2020	2025	2030	2035	2040
PA/MV RWQCP	City of Palo Alto[b]	818	1,750	1,750	1,750	1,750	1,750
PA/MV RWQCP	City of Mountain View	450	995	1,091	1,091	1,091	1,091
PA/MV RWQCP subtotal		1,268	2,745	2,841	2,841	2,841	2,841
Sunnyvale WPCP	City of Sunnyvale	717	1,236	1,306	1,419	1,419	1,419
Sunnyvale WPCP	Cal Water	0	220	261	261	261	261
Sunnyvale WPCP subtotal		717	1,456	1,567	1,680	1,680	1,680
SJ/SC RWF (SBWR)	City of Milpitas	856	1,150	1,995	2,207	2,470	2,686
SJ/SC RWF (SBWR)	City of Santa Clara	3,529	4,700	5,700	6,100	6,500	6,900
SJ/SC RWF (SBWR)	San José Municipal Water System	3,607	5,117	5,638	6,187	6,764	7,368
SJ/SC RWF (SBWR)	SJW[c]	1,964	4,073	6,853	8,351	8,369	8,369
SJ/SC RWF (SBWR) subtotal		9,956	15,039	20,186	22,845	24,103	25,324
SCRWA WWTP	City of Gilroy[b]	1,995	2,563	3,130	3,698	3,698	3,698
SCRWA WWTP	City of Morgan Hill	0	0	0	0	0	0
SCRWA WWTP subtotal		1,995	2,563	3,130	3,698	3,698	3,698
County total		13,936	21,803	27,725	31,065	32,323	33,543

Source: (Retailer 2015 UWMPs)

a. *Demands include both potable and non-potable use.*

b. *City of Palo Alto and City of Gilroy demands include recycled water used at the RWQCP and WWTP, respectively (e.g., for in-plant processes or irrigation).*

c. *SJW demands assume all planned extensions (Alignments D, E, Q, P, L, and K) are constructed.*

1.5 System Performance and Challenges

This section describes the condition and performance of each treatment facility and the associated distribution system, including age, capacity, reliability, and O&M considerations. This section also summarizes existing system deficiencies and challenges.

1.5.1 Treatment Facilities

Recent flows, design flows, and recycled water production capacity are summarized in Table 1-3. More detailed descriptions of each treatment facility are included below.

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Table 1-3. Treatment Facility Flows and Recycled Water Production

Facility	Average Inflow (mgd)[a]	Design ADWF (mgd)	Design PWWF (mgd)	Recycled Water Production Capacity (mgd)
PA/MV RWQCP	19.9	39.0	80.0	4.5
Sunnyvale WPCP	11.8[b]	29.5	40.0	4.0[c]
SJ/SC RWF (SBWR)[c]	99.0	167.0	271.0	38.0
SCRWA WWTP	6.5	8.5	N/A	9.0
SVAWPC[d]	5.7	N/A	N/A	8.0

a. Average inflows are from 2015-2017, from the California Integrated Water Quality System (CIWQS) database.

b. Per Sunnyvale staff, influent values reported to CIWQS were reduced by 0.5 mgd to more accurately report the flow entering the plant.

c. Sunnyvale WPCP production capacity assumes completion of Continuous Recycled Water Production Facilities project (expected late 2020).

d. SJ/SC RWF recycled water production is currently limited by filtration capacity.

e. SVAWPC produces purified water

ADWF = average dry weather flow

PWWF = peak wet weather flow

PA/MV RWQCP. The cities of Mountain View and Los Altos retired their WWTPs in 1968 and agreed to expand at the current site of the Palo Alto RWQCP to serve the growing local area. The RWQCP was completed in 1972 as a secondary treatment plant, with subsequent upgrades adding fixed-film reactors and dual-media filters (1980), more secondary clarifiers (1988), and ultraviolet (UV) disinfection (2010). The current treatment design capacity is 39 mgd for average dry weather flow and 80 mgd for peak wet weather flow. The RWQCP's coarse sand filter/chlorine disinfection train can produce up to 4.5 mgd of recycled water.

Based on the City of Palo Alto's 2012 Long Range Facilities Plan, much of the equipment at the RWQCP is approaching the end of its useful life and will require major rehabilitation or replacement (City of Palo Alto 2012). Replacing the solids incinerator is a high priority due to reliability and seismic vulnerability, though a new headworks and additional recycled water facilities (e.g., pumping, storage, filtration, and chlorine disinfection) are also primary concerns. New regulations—especially regarding nitrogen removal—may also require additional facility upgrades.

Sunnyvale WPCP. Originally constructed in 1956 as a primary treatment facility with a 7.5-mgd design capacity, the Sunnyvale WPCP has since added secondary (e.g., air flotation tanks, fixed-growth reactors, oxidation ponds) and tertiary (e.g., dual-media filters, chlorination) capabilities while expanding its capacity to 29.5 mgd ADWF and 40.0 mgd PWWF.

The City of Sunnyvale is in the process of implementing WPCP upgrades to allow for continuous production of recycled water. Previously, recycled water could only be produced in batches, which was inefficient and unreliable. These upgrades isolate recycled water treatment and allow simultaneous recycled water production and effluent discharge to the San Francisco Bay (SF Bay). Construction should be complete by late 2020, which will increase recycled water production capacity to 4 mgd.

According to the City of Sunnyvale's 2013 WPCP Master Plan, priority improvements include replacing primary treatment facilities (currently in construction), rehabilitating secondary and tertiary facilities, and converting secondary treatment to a conventional activated sludge process (City of Sunnyvale 2013a). These projects are scheduled to be constructed through 2037.

SJ/SC RWF/SBWR. Completed in 1956, SJ/SC RWF began as a 36-mgd WWTP for the City of San José and became a regional facility in 1959, when the City partnered with the City of Santa Clara. Over the next decade, other sewer districts and tributary partners joined, triggering expansion for both operations and to buffer the community from light, noise, chemicals, and odors. SJ/SC RWF has a design capacity of 167 mgd for ADWF and 271 mgd for PWWF. Recycled water production is limited by the filtration system capacity, approximately 38 mgd. Up to 8 mgd of this supply can originate from SVAWPC, while the remainder is conveyed through the SJ/SC RWF filtration building and effluent diversion pipeline to the transmission pump station (TPS) wet well.

The 2013 Plant Master Plan is the key planning guide for SJ/SC RWF improvements through 2040 (SBWR 2013). In addition to identifying and prioritizing $2.2B in future upgrades, the Plant Master Plan designates future SJ/SC RWF land uses and examines protection strategies for sea level rise. Repairs have already begun on the electrical distribution system and solids digestion. Other immediate-term (through 2020) projects include headworks modifications and upgrades to primary and secondary treatment, filtration, and sludge thickening.

SVAWPC. SVAWPC opened in 2014 to improve the quality of recycled water produced at the SJ/SC RWF and to serve as a demonstration facility for advanced water purification treatment. Using microfiltration (MF), reverse osmosis (RO), and UV disinfection, SVAWPC produces up to 8 mgd of effluent that is low in total dissolved solids (TDS), sodium, silica, and organic matter, while complying with the Title 22 non-potable requirements for tertiary disinfected effluents. When blended with the tertiary disinfected recycled water from SBWR, it decreases the salinity (targeting 500 milligrams per liter [mg/L] of TDS) and improves the quality of the blended flow that allows for a wider variety of irrigation, commercial, and industrial end uses. The feedwater to SVAWPC is secondary effluent from SJ/SC RWF.

SCRWA WWTP. The WWTP was built in 1990 to serve the cities of Gilroy and Morgan Hill and has an ADWF secondary treatment capacity of 8.5 mgd. SCRWA is currently in process of designing a modular expansion of its WWTP to add approximately 2.5 mgd of membrane bioreactors to produce tertiary effluent.

SCRWA's 2011 Capital Improvements Strategic Plan (CISP) prioritizes replacing emergency backup generators and installing a second influent force main (SCRWA 2011). Other improvements identified in the CISP (a UV disinfection facility, a third secondary clarifier, aeration system redundancy, additional pre-anoxic basins, and improved facility communications) have either been completed or are currently in construction.

1.5.2 Distribution System Infrastructure

This section reviews each recycled water distribution system (e.g., pump stations, storage tanks, and pipelines) in terms of capacity, condition, and reliability. Any significant O&M concerns are also discussed.

PA/MV. Palo Alto and Mountain View are each responsible for operating and maintaining facilities within their respective city limits. The PA/MV distribution system features a 0.5-million-gallon (MG) storage tank and a 6.24-mgd pump station that was originally constructed in 1980 along with pipelines to supply Shoreline Golf Course in Mountain View. The supply pipeline was extended in 1987 to serve additional customers in Mountain View, but its failure in 2001 temporarily suspended recycled water use in Mountain View. Subsequently, a new recycled water pipeline was constructed in 2009 to serve the North Bayshore area of Mountain View.

Hydraulic analysis of the recycled water distribution system conducted as part of the City of Mountain View's 2014 Recycled Water Feasibility Study did not identify significant deficiencies within Mountain View; however, the Shoreline Golf Course recycled water irrigation system requires significant improvements, including pipe and possibly pump replacement. No other major issues are known for the Palo Alto pipeline network, though reliability is a concern because the system lacks a potable water backup supply or significant storage.

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Sunnyvale. The WPCP recycled water pump station was completed in 1994 and modified in 2000 to increase its total capacity to 8 mgd. Actual pumping rates (roughly 6.5 mgd) depend on the system pressure set at the San Lucar storage tank pressure sustaining valve. Total system storage is 2.0 MG, comprising the 1.5-MG San Lucar storage tank and a 0.5-MG surge tank on the same site. Sunnyvale's portion of the recycled water distribution system was built between 1992 and 2000, and the San Lucar tank and pump station (7.9 mgd firm capacity) were constructed in 2000.

Overall, the Sunnyvale recycled water system is very reliable, with potable water backups at the WPCP pump station and the San Lucar tank, and the ability to feed the entire system from the SLPS. Valley Water recently upgraded SLPS to create a second pressure zone and supply the Wolfe Road recycled water pipeline. The SLPS pumps flow both south into the Wolfe Road recycled water pipeline and north to the rest of the Sunnyvale recycled water distribution system.

SBWR. The SBWR distribution system was constructed in the late 1990s and early 2000s. The TPS can deliver up to a firm capacity of 40.0 mgd of recycled water, which can be stored in three tanks (combined storage capacity of 9.6 MG) in the distribution system. A 2010 Condition Assessment concluded that the system is generally well-maintained and in good condition, but some facilities, including communications, valves, and TPS pumps and electrical components, are nearing the end of their useful lives.

As peak hour recycled water demands approach distribution system capacity, recycled water production requires high manual control and planning, which strains staff resources and compromises reliability. The single backbone pipeline also poses a vulnerability. Though each municipality (City of San José, City of Santa Clara, and City of Milpitas) is responsible for maintaining facilities within their limits (and SJW maintains the facilities it owns), staffing is further stretched due to long distances between isolation valves, which reduces operational flexibility and potentially increases system outages.

SJW is responsible for O&M of the recycled water pipelines it constructed and owns that are part of the SBWR distribution system. All the SJW-owned infrastructure has been constructed since 2010 and is expected to be in good condition.

The 2014 SBWR Strategic and Master Planning study identified NPR opportunities for each retailer (SBWR 2014). Within each service area, increased use by customers along existing pipelines, redevelopment, and conversion of selected customers to recycled water is expected to continue. Near-term recycled water use was expected to represent up to 3,900 AFY of additional demand by 2020. The projection reflects a contractual commitment to supply up to 1,200 AFY to SJW for extensions within the SJW service area.

SCRWA. The SCRWA system was originally constructed in the late 1970s, with new facilities (pipelines, pump stations, and a closed tank reservoir) added around 2000. Recycled water from the WWTP feeds a 3-MG reservoir. Two on-site pump stations draw from the storage reservoir. Pump Station 93 (6-mgd capacity) supplies the pipeline system north of the WWTP, while Pump Station 94 (5.2-mgd capacity) feeds the southern system. The northern system also has a 1.5-MG storage tank, for 4.5 MG of total storage.

The City of Gilroy operates and maintains the distribution system in partnership with Valley Water. Redundancy from system storage protects against treatment disruptions, but pumping is vulnerable because Pump Station 94 operates above its firm capacity. There are plans to add a new pump, such that both pump stations operate within firm capacity.

1.5.3 System Deficiencies

Each system faces extensive upgrades due to aging equipment, increased flows/loads, and/or more stringent regulations. Table 1-4 lists the more specific and unique challenges for each system.

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Table 1-4. Recycled Water System Deficiencies

System	Quantity	Water Quality	Reliability
PA/MV	N/A	• High salinity	• Insufficient storage • No potable water backup
Sunnyvale	N/A	• High salinity • Recycled water has greenish tint	• Insufficient storage • Recycled water production highly manual
SBWR	• Peak hour demands approaching system capacity	N/A	• Insufficient distribution system storage • Lack of isolation valves
SCRWA	N/A	• High salinity	• No potable water backup

N/A = not applicable

Across all four systems, some recycled water infrastructure is nearing the end of its useful life and requires significant rehabilitation and replacement. Further, treatment plant operators may need to replace newer, functioning equipment as they anticipate future regulations (e.g., nutrient removal). These capital improvement projects will further stretch budgets and personnel, who need to balance day-to-day operation with planning, design, and construction efforts.

Planned capital improvements are further discussed in Section 3.2.2.

Section 2: Potable Reuse Research and Planning

Valley Water has undertaken several research efforts to evaluate IPR through GWR (groundwater spreading or injection) and direct potable reuse (DPR) as additional sources of water supply with the following goals:

- Demonstrate compliance with the regulatory requirements for GWR at both pilot and full scale
- Evaluate alternatives to upgrade the UV disinfection system to an advanced oxidation process (AOP)
- Evaluate ozone with biologically active filtration (BAF) to spread GWR and in DPR
- Educate stakeholders on SVAWPC's ability to create high-quality water for PR

Valley Water's Expedited Purified Water Program evaluated several options for PR. Through this effort, Valley Water identified a recommended alternative that involves (1) delivering at least 24 mgd (24,000 AFY) of full advanced treatment (FAT) (i.e., MF, RO, and an AOP) water by 2025 from a new facility or from an expanded SVAWPC to the Los Gatos Ponds for groundwater spreading (Valley Water 2018) and (2) future expansion to supply up to 45,000 AFY of PR. The recommended alternative, however, may change based on this Master Plan's outcomes.

2.1 Full-Scale Performance Testing

Valley Water performed testing during a 12- to 18-month period to evaluate the ability of a FAT train to comply with GWR regulations (2016 PR Demonstration Test Plan). The testing looked at both the performance of individual unit processes as well as an overall water quality analysis. Over the course of the testing period, a high degree of treatment performance was demonstrated for each of the unit processes, as described below (Valley Water 2016).

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2.1.1 Microfiltration

MF performance was evaluated at full scale using both typical performance surrogates (e.g., turbidity, membrane integrity testing) and water quality testing. The test results showed a high degree of removal of bacteria, protozoa, and particulate matter.

2.1.2 Reverse Osmosis

In addition to measuring typical performance surrogates (e.g., electroconductivity and total organic carbon [TOC]), Valley Water used full-scale challenge testing to demonstrate greater than 3-log removal of virus under baseline conditions and 2-log removal under compromised conditions (i.e., with intentional damages to the RO membrane integrity (Valley Water 2016). The removal of electroconductivity and TOC were both consistently lower than the observed virus removal, making these conservative surrogates for full-scale RO monitoring.

2.1.3 UV Treatment

Because SVAWPC was originally intended to improve the quality of recycled water produced at the SJ/SC RWF, the UV system was designed to meet Title 22 disinfection requirements. There was not an explicit goal to also achieve the higher UV doses needed for AOPs described in the groundwater injection regulations. Consequently, additional work was performed to evaluate the minimum design criteria for a future UV/AOP system (Valley Water 2016). An extensive suite of chemicals was evaluated during the testing, with only one constituent—N-nitrosodimethylamine (NDMA)—exceeding the health-based thresholds. NDMA is one of two constituents that drives sizing of the UV system. A future UV/AOP system is anticipated to provide an additional barrier to reduce the concentration of NDMA below the notification level of 10 nanograms per liter (ng/L).

2.1.4 Monitoring

Throughout testing, Valley Water evaluated the performance of the treatment barriers using a variety of surrogate parameters. These data will be used to select the monitoring parameters used to confirm treatment compliance toward the required 12/10/10 pathogen reduction goals for PR. The testing also revealed challenges of using different surrogates and identified issues that will need to be addressed at full scale, such as the appropriate selection and maintenance of UV transmittance meters for the UV/AOP system.

2.1.5 Water Quality

Water quality testing demonstrated compliance with the full suite of criteria, including regulated contaminants, nutrients, and contaminants of emerging concern (CECs); the only exception was exceedances in NDMA. This was anticipated based on the lack of a high-dose UV/AOP system, a known issue with the existing treatment train. Valley Water's 2016 PR Demonstration Test Plan included pilot UV/AOP studies.

2.2 Pilot UV/AOP Testing

Valley Water tested a pilot UV/AOP system using Wedeco LBX90 UV reactors capable of providing the high UV doses needed to drive AOP reactions. The testing included validation of the reactor at different conditions and evaluation of surrogate monitoring methods. Through testing, Valley Water demonstrated that the requirement for 0.5-log reduction of 1,4-dioxane can be achieved through a UV dose of 800 millijoules per square centimeter with 6 mg/L of hydrogen peroxide (H_2O_2) (Valley Water 2016). The testing also shows that use of an alternative oxidant (hypochlorite) does not provide the same performance.

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2.3 Pilot Ozone/BAF Testing

A pilot ozone/BAF system was used to evaluate two potential future scenarios: (1) production of a tertiary filtered water for groundwater spreading, and (2) pretreatment for a future RO-based DPR treatment train (see Figure 2-1). In the context of groundwater spreading, ozone/BAF can further reduce TOC (in the range of 20 to 40 percent) while providing protection against pathogens and a wide range of chemical contaminants. Adding ozone/BAF has also been evaluated as a potential pathway to DPR when coupled with FAT (State Water Resources Control Board 2016; Pecson et al. 2017). The pilot testing evaluated performance using both tertiary and secondary feedwaters to simulate groundwater spreading and DPR treatment trains, respectively, as described below.

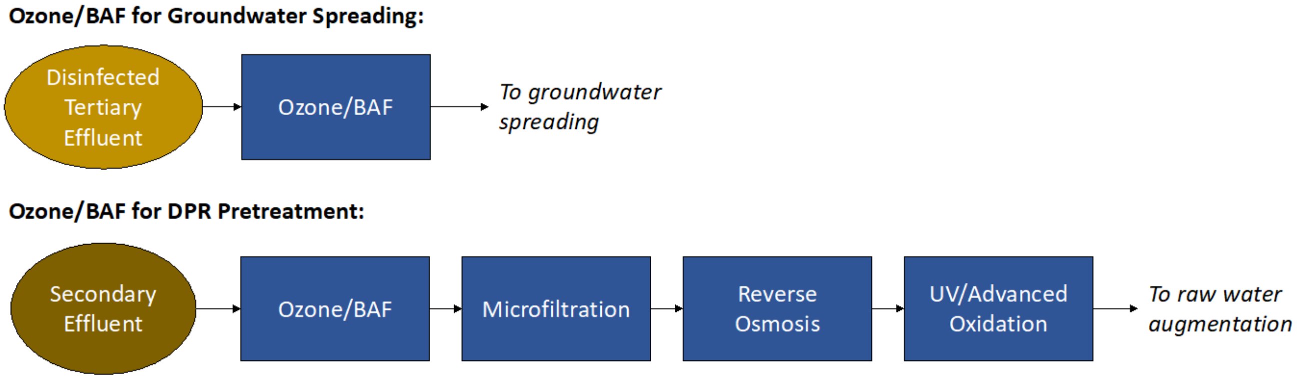
Ozone/BAF for Groundwater Spreading:
Disinfected Tertiary Effluent
Ozone/BAF
To groundwater spreading
Ozone/BAF for DPR Pretreatment:
Secondary Effluent
Ozone/BAF
Microfiltration
Reverse Osmosis
UV/Advanced Oxidation
To raw water augmentation

Figure 2-1. Treatment trains investigated with ozone/BAF piloting

2.3.1 Ozone/BAF for Groundwater Spreading

Valley Water decided in 2017 to use FAT treatment for GWR options to protect the quality of the groundwater basin. At the same time, Valley Water has committed to periodically reviewing the technologies used for GWR. Along these lines, Valley Water evaluated a non-RO based treatment option for groundwater spreading that involved using ozone and BAF treatment. To move forward with this option, additional considerations include compliance with the Santa Clara Basin Salt and Nutrient Management Plan, antidegradation analysis, and public outreach efforts.

To test the technical feasibility of this treatment option, tertiary feedwater was fed to the O3/BAF pilot to mimic a future groundwater spreading project. Testing evaluated the ability of ozone/BAF to reduce TOC, CECs, and total nitrogen (Valley Water 2016). The goal was to demonstrate whether upstream ozone/BAF could reduce the level of soil aquifer treatment (SAT) required and potentially allow for greater project capacity. One key parameter was TOC because it limits the maximum fraction of recycled water that can contribute to the groundwater. Testing evaluated a range of both ozone dose (i.e., the ozone-to-TOC ratio) and BAF empty bed contact times to maximize TOC and CEC destruction while minimizing costs.

Operational challenges that arose were related to: (a) ozone control, (b) TOC reduction, (c) nutrient compliance, and (d) NDMA control. Over the course of testing, it was difficult to control ozone dosing, a problem that may have been caused by the presence of chlorine in the ozone feedwater. TOC removal through the pilot was lower than anticipated (roughly 20 versus 40 percent), which may have resulted from the residual chlorine affecting the biological populations on the BAF. Consequently, the testing did not confirm whether the ozone/BAF can provide sufficient TOC reduction to pursue spreading. The Valley Water team recommended additional soil column testing to further explore this option (Valley Water 2016).

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Another challenge was that total nitrogen levels could not be reduced below the 10 mg/L requirement for GWR. This was largely due to the presence of nitrate, for which there are no barriers in the tertiary treatment train (filtration and disinfection). Remedying this will require modifications to the secondary process (e.g., additional biological denitrification) or additional subsequent treatment barriers (e.g., denitrifying filters or ion exchange).

The water quality testing included several groups of chemical contaminants, including both regulated and unregulated chemicals. One of the most challenging chemicals to control was NDMA. The feedwater itself had elevated NDMA levels (in excess of 200 ng/L at times) with ozone increasing these levels by up to an additional 50 ng/L. BAF was able to reduce the NDMA concentrations to 120 to 180 ng/L, though additional attenuation through SAT would be required to comply with the 10 ng/L notification level. SAT's ability to provide this protection must be confirmed through soil column or full-scale testing.

2.3.2 Ozone/BAF as Pretreatment for DPR

Valley Water also evaluated ozone/BAF as pretreatment to a FAT train in a potential DPR scenario. The testing demonstrated 25 percent reduction of TOC in the secondary feedwater. NDMA was less prevalent in the secondary effluent compared to the tertiary effluent, with levels in the 50 to 60 ng/L range. Ozone/BAF effluents contained NDMA in the 19 to 33 ng/L range, which is above the 10 ng/L notification level, but well within the range of values that can be treated downstream by UV/AOP. While nitrate was a challenge for groundwater spreading, it will not be a concern for injection because the RO will likely reduce these levels below the 10 mg/L limit. The high degree of CEC reduction was in line with the findings from the tertiary effluent. Challenge testing with an indicator virus (MS2 coliphage) showed greater than 5-log inactivation with ozone-to-TOC ratios of 0.6 and higher.

Although Valley Water's pilot testing demonstrated that ozone/BAF could be an effective water purification strategy, a comparison of alternatives in Valley Water's Expedited Purified Water Program Plan led them to recommend an IPR scenario that includes FAT for groundwater spreading. Ozone/BAF scenarios may still be considered for future projects, subject to additional site-specific analysis.

2.4 Groundwater Conditions

Groundwater is a highly important resource in the County, supplying nearly half the county's water in some years. The groundwater basin operational storage capacity is over twice that of the local reservoirs, and the basins comply with Basin Plan Objectives. Several studies are underway to evaluate the potential impact of IPR, including groundwater modeling, groundwater monitoring, and dissolution studies (Mohr 2017).

2.4.1 Groundwater Modeling

Valley Water has updated its groundwater flow model to simulate potential IPR scenarios (Todd Groundwater 2017b). One critical aspect of this modeling was determining the retention time provided in the aquifer, because this value can impact project feasibility, capacity, and treatment required. The modeling evaluated GWR through both spreading and injection.

A numerical groundwater flow model was used to simulate changes in groundwater levels and flow under various IPR scenarios: percolation at the existing Los Gatos Ponds, injection into potable supply aquifers using new wells north of the Los Gatos ponds, and percolation at/near the Ford Pond site. The model was used to model horizontal travel times to nearby potable supply wells. For both the Los Gatos Ponds and injection well scenarios, more than 2 years of travel time was estimated between the spreading site and downgradient water supply wells. Shorter retention times were observed at the Ford Ponds (1 to 12 months) with several municipal wells located within 6-months' travel time. To determine compliance with the regulatory requirements for response retention time, modeled travel times must be divided by two, i.e., a 1-

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year modeled travel time would represent a retention time of 6 months for regulatory permitting purposes. Based on these results, the use of the Los Gatos Ponds is expected to comply with the retention time requirements of the GWR regulations.

2.4.2 Groundwater Monitoring

Valley Water has constructed several groundwater monitoring wells located 2 weeks to 6 months downgradient of the potential IPR facilities (Todd Groundwater, 2017c). The wells allow for water quality sampling at multiple depths and provided soil cores used for the dissolution studies.

2.4.3 Dissolution Studies

Dissolution studies were conducted to determine if FAT water used for IPR could react with aquifer sediments to cause the dissolution or leaching of metals into groundwater (Todd Groundwater, 2017a). Test conditions were developed with the dual objectives of protecting the purified water transmission piping and fittings from corrosion and preventing dissolution of harmful constituents from aquifer materials into groundwater (HDR, 2017).

Two rounds of soil testing were conducted, using samples from both the Ford Ponds and Los Gatos Ponds. Dissolution testing provided strong evidence that interaction of buffered purified water and aquifer sediments will not result in significant leaching of metals to groundwater. Specific water quality recommendations for the purified recycled water were also developed as a result of the testing.

2.5 Independent Advisory Panel Engagement

Since 2013, Valley Water has engaged the National Water Research Institute as part of an Independent Advisory Panel (IAP) to provide third-party, science-based review of PR as a potential future water supply option. To date, Valley Water has held five annual IAP meetings to help Valley Water staff and local policymakers make informed decisions about future PR applications for Valley Water’s service area. After each meeting, the IAP issues a panel report that includes a concise list of findings and recommendations. The gap analysis (see Section 4) includes the recommendations from the most recent IAP Panel Report (Crook et al. 2017).

Section 3: Expanded Reuse Opportunities and Considerations

Valley Water is exploring opportunities to expand water reuse throughout the County. This section provides a preliminary assessment of the volume of water available for reuse, a summary of planned and potential interties and CIP projects, and other considerations for expanding NPR and introducing PR.

3.1 Preliminary Assessment of Volume Available and NPR/PR Split

Before exploring conceptual and feasible water reuse alternatives, Valley Water analyzed current and projected conditions at each of the four recycled water producers in the County to estimate the approximate volume of water available for reuse.

3.1.1 Volume Available

Valley Water requested data from the Palo Alto RWQCP, Sunnyvale WPCP, SJ/SC RWF, and SCRWA WWTP to establish current conditions and projected future conditions to determine the potential volume available for NPR and PR. Current monthly averages and annual projections were collected for the following flows:

- Plant influent

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- Evaporation and/or other losses (e.g., in-plant process losses)
- Required flow for environmental benefit
- NPR demands (including recycled water used at the Palo Alto RWQCP and SCRWA WWTP)
- Plant effluent (current only)

Using this information, a flow balance was created to determine the remaining effluent available for discharge, blending, or additional reuse (see Figure 3-1). In an ideal situation, the volume available for reuse (both NPR and PR) will equal the plant influent less losses (e.g., evaporation and in-plant process losses) and other flow requirements (e.g., for environmental benefits), and the volume available as source water for PR will equal the total volume available less the NPR demands. Treatment processes to produce purified water for PR do not result in 100 percent recovery; thus, some of the available source water for PR will be rejected in the ROC stream or may be used to dilute the ROC for discharge, depending on the findings of the ROC management study (refer to Section 3.1.3 on ROC management).

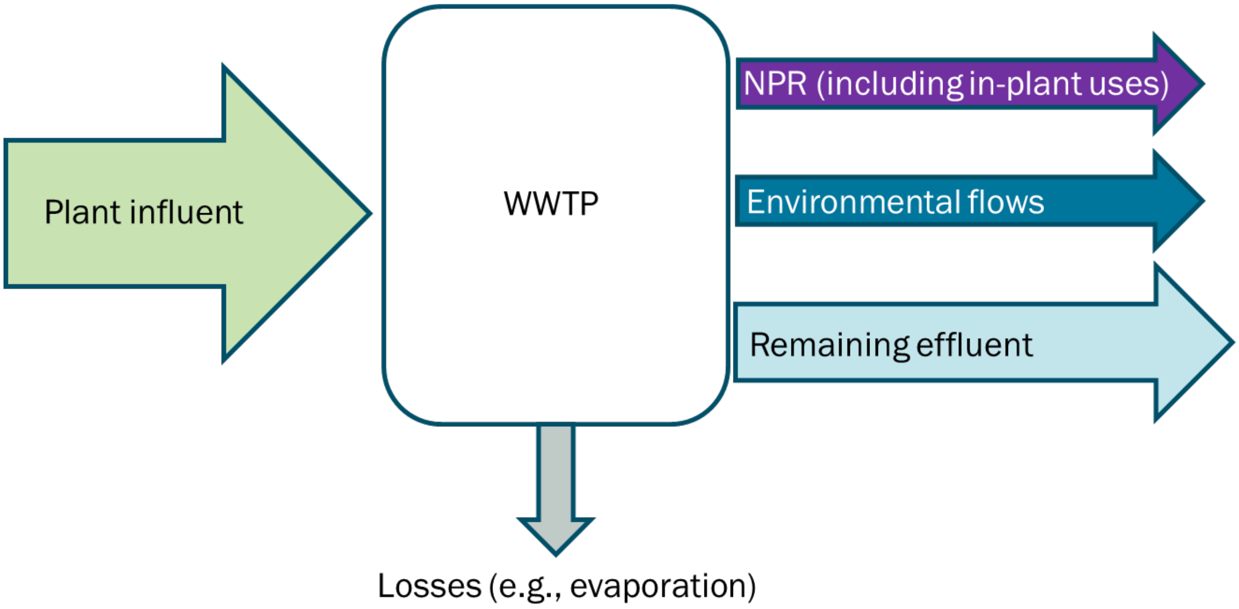

Figure 3-1. Example flow streams were identified to establish the baseline condition

3.1.1.1 Baseline (Current) Conditions

This section provides details on plant influent, outflow streams, internal WWTP NPR, and monthly distribution factors.

Plant Influent. To summarize current conditions, monthly influent flow data for each of the four WWTPs during 2015 (a critically dry year), 2016 (a below normal to dry year), and 2017 (a wet year) were collected from the CIWQS database. These flow data were then used to calculate the ADWF (i.e., the lowest consecutive 3-month average). To capture seasonal variation, monthly distribution factors were calculated by dividing the average flow for each month by the ADWF; these factors were then multiplied by future ADWF projections to develop monthly distribution curves. Monthly plant effluent data were also collected from the CIWQS database to backcheck the water balance.

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Plant Outflow Streams. Flow streams leaving the plant include evaporative losses, waste removal, flows for environmental benefits, recycled water delivered to offsite customers, and WWTP discharge to the SF Bay:

- Average monthly evaporative losses, typically between 1 and 2 mgd, were identified for the Sunnyvale WPCP, associated with the use of its current ponds as a part of its treatment process[2]. The Palo Alto RWQCP recirculates some effluent for in-plant uses (e.g., wet scrubber water and filter backwash), and experiences a 20 percent loss of the recirculated flow (an average of about 0.3 mgd). Palo Alto also uses some recycled water for in-plant processes and landscape irrigation around the Palo Alto RWQCP; however, these flows are included in the NPR demands, as described in the 2015 UWMP. No evaporation or other losses were identified for the SJ/SC RWF or SCRWA WWTP.
- State Water Resources Control Board tentative and adopted orders for recycled water use and National Pollutant Discharge Elimination System (NPDES) permits for each facility were reviewed to identify existing minimum flows for environmental benefit. The Renzel Marsh project for the Palo Alto RWQCP, with an average current flow of 1 mgd, was the only environmental benefit project identified in these documents.
- Flow data for NPR production and/or deliveries were collected from the four WWTPs and converted to monthly averages across the same time frame (2015–17[3]). These data do not necessarily include the contractually obligated flows discussed in Section 1.3.2. For example, the City of Palo Alto is contractually obligated to provide up to 3 mgd (instantaneous basis) of recycled water to the City of Mountain View, but current actual NPR demands are much lower. To capture seasonal variation, monthly distribution factors were calculated by dividing the monthly average recycled water production by the annual average. These factors were multiplied by future annual NPR projections to develop monthly distribution curves.
- The monthly plant effluent data for flows discharged to the environment (including flows required for environmental benefit) were collected from the CIWQS database.

From this information, the baseline condition was established. The monthly distribution factors for influent and NPR demand were used in the next step to estimate projected future conditions. The process for synthesizing this information is illustrated in Figure 3-2.

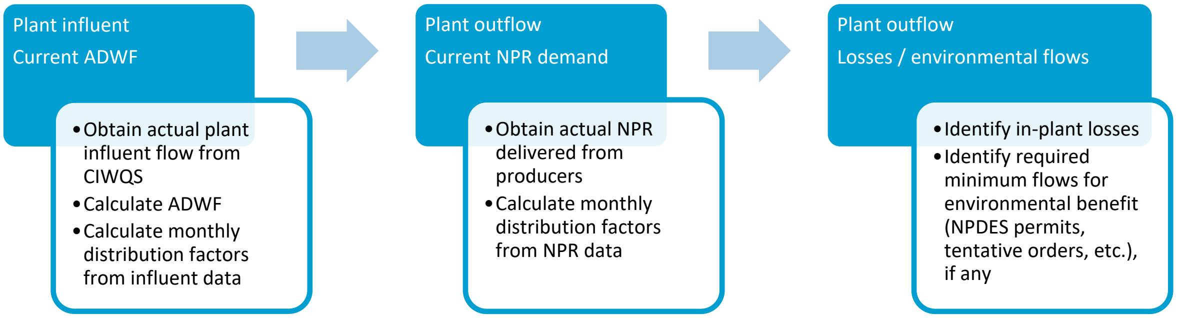
Plant influent
Current ADWF
•Obtain actual plant influent flow from CIWQS
•Calculate ADWF
•Calculate monthly distribution factors from influent data
Plant outflow
Current NPR demand
•Obtain actual NPR delivered from producers
•Calculate monthly distribution factors from NPR data
Plant outflow
Losses / environmental flows
•Identify in-plant losses
•Identify required minimum flows for environmental benefit (NPDES permits, tentative orders, etc.), if any

Figure 3-2. Process for analyzing existing data and establishing the baseline condition

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[2] Current Sunnyvale WPCP evaporative loss data was received from Sunnyvale WPCP staff.

[3] NPR volumes from Sunnyvale WPCP were only available for 2015–16.

Internal WWTP NPR. Some facilities produce recycled water for internal treatment plant uses, such as washdown water. The in-plant recycled water is typically discharged within the treatment plant (e.g., to the headworks of the WWTP) and thus does not affect the volume entering or exiting the plant; however, recycled water for some on-site uses (e.g., irrigation) may reduce the amount available to meet other NPR demands.

For this evaluation, Valley Water used NPR demand projections from the retailers' 2015 UWMPs, which include uses of recycled water at the Palo Alto RWQCP[4] and SCRWA WWTP. To be conservative, these in-plant flows were considered part of the projected NPR demand and unavailable for additional reuse. Figure 3-3 demonstrates the in-plant uses as a portion of total NPR demand reported for 2015.

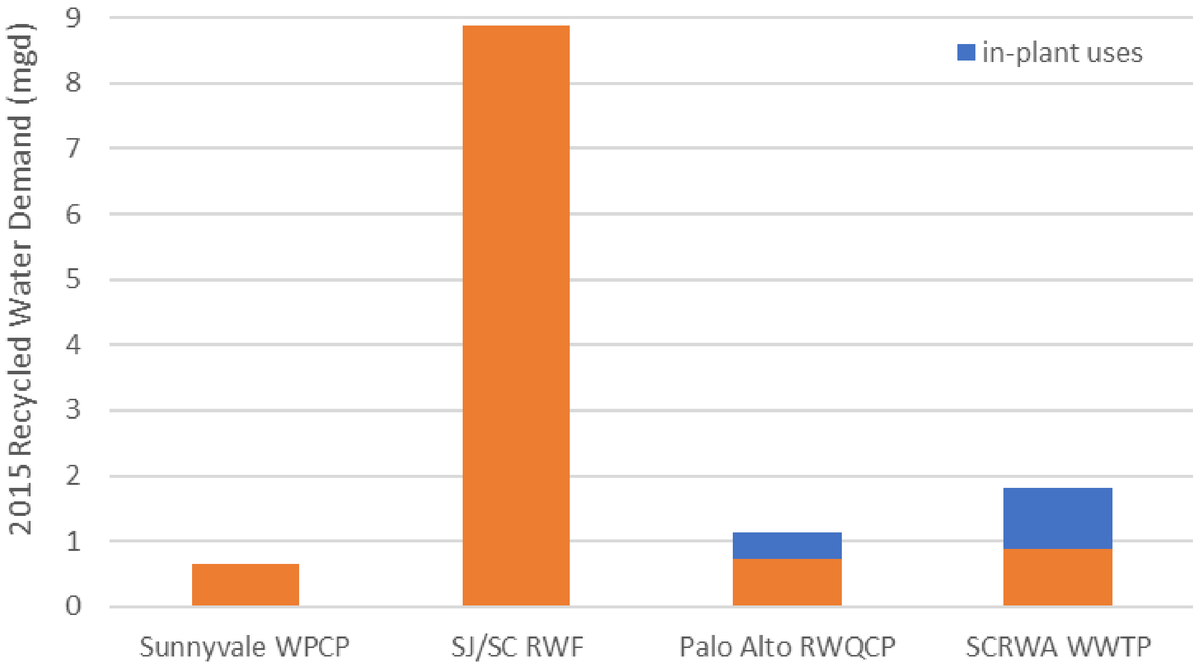

Figure 3-3. 2015 recycled water demand, as presented in 2015 UWMPs

Monthly Distribution Factors. Current plant influent and the resulting monthly distribution factors (based on ADWF) are summarized in Table 3-1. The current NPR demand from each facility and the resulting monthly distribution factors (based on average NPR demand) are summarized in Table 3-2. Future flow projections for plant influent and NPR demand are presented on the basis of ADWF and average NPR demand, respectively, and can be multiplied by these distribution factors to determine the monthly variation in projected influent and NPR demand.

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[4] Per Palo Alto's 2015 UWMP, both recycled water and final effluent are used for processes at the RWQCP; however, only the recycled water portion is included in the NPR demands. In-plant process losses of effluent (approximately 0.3 mgd) are considered separately.

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Table 3-1. Current Flows: Plant Influent (mgd) and Monthly Distribution Factors

	Sunnyvale WPCP [a]		SJ/SC RWF		Palo Alto RWQCP		SCRWA WWTP	
Month	Plant Influent (2015–2017 average)	Monthly Distribution Factor (ADWF)	Plant Influent (2015–2017 average)	Monthly Distribution Factor (ADWF)	Plant Influent (2015–2017 average)	Monthly Distribution Factor (ADWF)	Plant Influent (2015–2017 average)	Monthly Distribution Factor (ADWF)
Jan.	13.3	1.2	104.6	1.1	22.3	1.2	7.1	1.2
Feb.	14.1	1.3	108.0	1.1	24.3	1.4	8.0	1.3
March	13.3	1.2	104.5	1.1	22.6	1.3	7.5	1.3
April	12.3	1.1	99.4	1.0	21.1	1.2	6.9	1.2
May	11.7	1.1	97.6	1.0	20.4	1.1	6.4	1.1
June	11.4	1.1	97.2	1.0	19.9	1.1	6.1	1.0
July	11.1	1.0	94.2	1.0	18.2	1.0	6.0	1.0
Aug.	11.1	1.0	97.9	1.0	17.9	1.0	6.0	1.0
Sep.	10.7	1.0	97.1	1.0	17.5	1.0	6.0	1.0
Oct.	10.9	1.0	98.0	1.0	18.1	1.0	6.0	1.0
Nov.	11.3	1.0	96.6	1.0	18.5	1.0	6.0	1.0
Dec.	11.1	1.0	95.0	1.0	18.0	1.0	6.0	1.0
ADWF	10.9		96.3		17.8		6.0	

a. The Sunnyvale WPCP influent that is reported to CIWQS includes, on average, 0.5 mgd of internal plant recycle (as clarified by Sunnyvale staff) and does not reflect actual flow coming into the plant. Thus, the Sunnyvale influent numbers, as reported to CIWQS, were reduced by 0.5 mgd to more accurately report the flow entering the plant.

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Table 3-2. Current Demands: NPR Demand (mgd) and Monthly Distribution Factors for Each Plant

	Sunnyvale WPCP		San José/Santa Clara RWF		Palo Alto RWQCP		SCRWA WWTP	
Month	NPR demand (2015–2017 average)	Monthly Distribution Factor (average NPR demand)	NPR Demand (2015–2017 average)	Monthly Distribution Factor (average NPR demand)	NPR Demand (2015–2017 average)	Monthly Distribution Factor (average NPR demand)	NPR Demand (2015–2017 average)	Monthly Distribution Factor (average NPR demand)
Jan.	0.4	0.4	6.7	0.6	0.1	0.2	1.2	0.7
Feb.	0.4	0.5	6.5	0.5	0.2	0.3	1.0	0.5
March	0.6	0.7	7.4	0.6	0.3	0.4	1.4	0.8
April	0.9	1.0	9.6	0.8	0.5	0.9	1.7	0.9
May	1.2	1.3	13.6	1.1	0.9	1.4	2.0	1.1
June	1.5	1.7	17.9	1.5	1.0	1.7	2.6	1.4
July	1.4	1.6	19.5	1.6	1.1	1.8	2.8	1.5
Aug.	1.5	1.7	19.0	1.6	1.2	2.0	2.9	1.6
Sep.	1.4	1.5	17.2	1.4	1.0	1.6	2.2	1.2
Oct.	0.9	1.0	14.3	1.2	0.7	1.1	1.9	1.0
Nov.	0.3	0.4	7.4	0.6	0.2	0.4	1.3	0.7
Dec.	0.2	0.2	5.9	0.5	0.2	0.3	1.2	0.6
Average NPR Demand	0.9		12.1		0.6		1.9	

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3.1.1.2 Projected Conditions

To develop future estimates for plant influent and recycled water demand, various planning documents from multiple agencies were reviewed. As the Master Plan progresses, estimates may be refined if more recent data and/or projections become available.

Plant Influent. Individual recycled water master plans provided the basis for plant influent flow rates. These plans included projections for ADWF (i.e., the lowest consecutive 3-month average). Actual ADWF for 2015–2017 was lower than projected in the plant recycled water master plans, likely due to short-term conservation savings and long-term water use reductions implemented during the drought. Therefore, the ADWF projection curves were adjusted to reflect the lower trends as informed by actual 2015–2017 ADWF. For example, Figure 3-4 shows how the projection curve was shifted to account for 2015–2017 actual ADWF into the PA/MV RWQCP. The plant influent monthly distribution factors calculated from current data were applied to the single ADWF values for future years to estimate the monthly distribution of expected plant influent (e.g., more flow in the winter months, less influent in the summer), along with average annual flows.

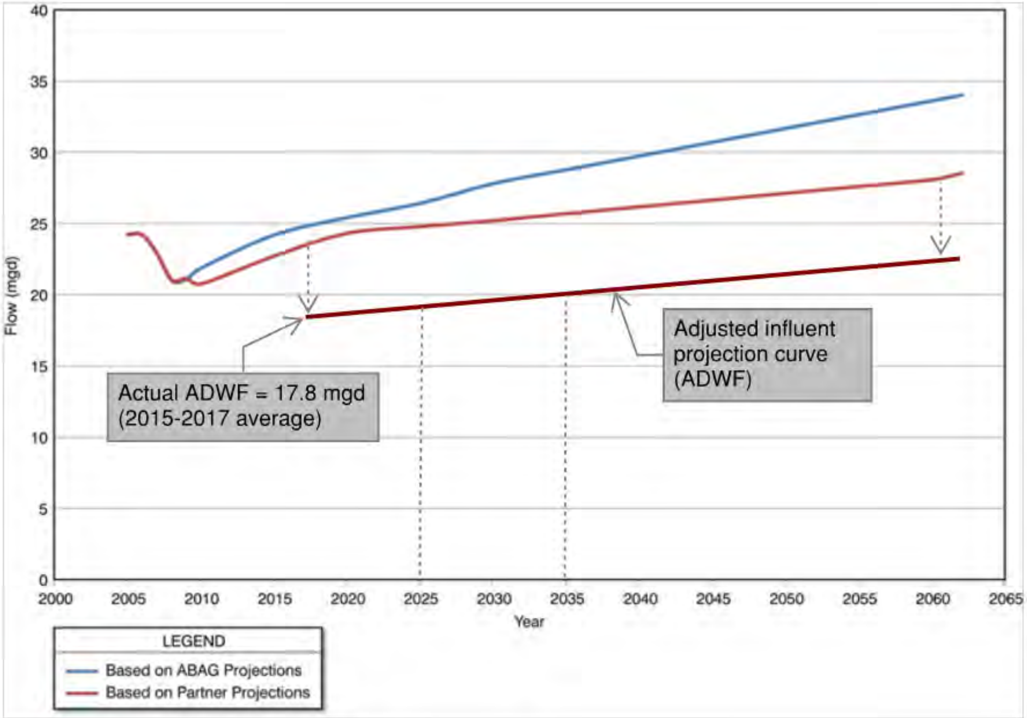

Figure 3-4. ADWF projections from the PA/MV RWQCP Long Range Facilities Plan, adjusted for current flows

Source: (City of Palo Alto 2012).

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Plant Outflow Streams. Plant effluent streams were estimated as follows:

- Based on input from the City of Sunnyvale, future average losses at the Sunnyvale WPCP associated with its pond system are assumed to be 4 mgd, including flows for capping, evaporation, and other losses. Sunnyvale WPCP is expected to be in split-flow conventional activated sludge configuration in 2025, and full conventional activated sludge by 2035. However, a minimum of 4 mgd must be sent to the ponds to maintain a viable microbial community in 2025, and there is no plan identified for the ponds in 2035; therefore, the flow analysis considers both the current evaporative losses and the potential future average losses of 4 mgd through 2035.
- The Renzel Marsh project for Palo Alto RWQCP was the only environmental benefit project assumed for future estimates. Renzel Marsh is currently designed to receive 1 mgd; however, based on input from Palo Alto staff, Palo Alto is considering a potential expansion, which would accept 3 mgd. The flow analysis considers current average flow (1 mgd) as well as an average future flow of 3 mgd. In addition, the flow analysis includes a 0.3-mgd loss to account for the 20 percent loss of recirculated effluent used for in-plant processes (e.g., wet scrubber water and filter backwash), per Palo Alto's 2015 UWMP.
- Recycled water demand estimates (including recycled water used at the Palo Alto RWQCP and SCRWA WWTP) were obtained from individual retailers' UWMPs. The years 2025 and 2035 overlapped for all four WWTPs, so these 2 years were used to estimate potential water available for reuse in the future. The recycled water demand monthly distribution factors calculated from current data were applied to the projected recycled water demands for future years to estimate monthly distribution of expected recycled water demand (e.g., more demand in the summer months, less demand in the winter). Some of the partner agencies, including the City of Palo Alto, are currently in the process of updating their demand projections. These updated projections may be incorporated into the final Master Plan.

The remaining effluent—which provides an estimate of potential volume available for discharge, blending, or as feed water for an AWPF—was calculated for each facility by subtracting the plant outflow streams from the plant influent in 2025 and 2035. The process used to develop these estimates is illustrated on Figure 3-5.

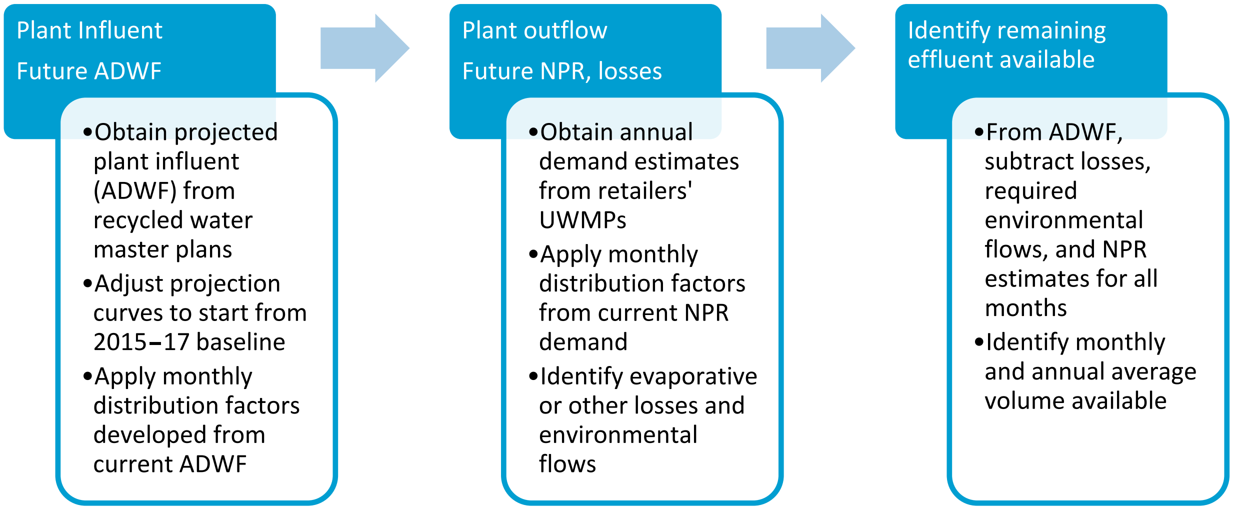
Plant Influent
Future ADWF
•Obtain projected plant influent (ADWF) from recycled water master plans
•Adjust projection curves to start from 2015–17 baseline
•Apply monthly distribution factors developed from current ADWF
Plant outflow
Future NPR, losses
•Obtain annual demand estimates from retailers' UWMPs
•Apply monthly distribution factors from current NPR demand
•Identify evaporative or other losses and environmental flows
Identify remaining effluent available
•From ADWF, subtract losses, required environmental flows, and NPR estimates for all months
•Identify monthly and annual average volume available

Figure 3-5. Process used to estimate remaining effluent available for discharge, blending, or as AWPF feed

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Flows Available for Additional Reuse. Based on the analysis above, the remaining effluent available for discharge, blending, or additional reuse (above and beyond the 2015 UWMP demand projections by retailers, as shown in Table 1-2) was calculated; annual averages are summarized in Table 3-3 for the years 2025 and 2035. Annual average flows may not be available year-round, particularly in the summer months. Furthermore, some agencies have contractual agreements restricting the use of certain flows, as discussed in Section 1.3.2. For example, the City of Palo Alto is contractually obligated to provide up to 3 mgd (instantaneous basis) of recycled water to City of Mountain View. That is, the City of Palo Alto does not have the rights to allocate that supply to other uses, which effectively reduces the calculated flow available to allocate/wholesale to Valley Water in all months. The remainder of the 3 mgd not used by the City of Mountain View is potentially available for Valley Water to use during most months of the year, but it would require that Valley Water acquire rights to that water. Flow estimates will be refined throughout the Master Plan as new information becomes available.

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Table 3-3. Preliminary Estimates of Effluent Remaining for Discharge, Blending, or Additional Reuse (Beyond Existing Plans for NPR) in 2025 and 2035

Partner Agency	Available Influent, mgd (AFY)[a]	NPR Demands, mgd (AFY)	Losses/Environmental Flows, mgd (AFY)	Remaining Effluent, mgd (AFY)[b]	Current Contractual Obligation[c]
2025					
Palo Alto RWQCP	21.0 (23,400)	2.5 (2,800)	1.3-3.3[d] (1,500–3,700)	15.2-17.2 (16,900–19,200)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale WPCP	14.6 (16,300)	1.4 (1,600)	1.4-4.0[e] (1,600–4,500)	9.2-11.8 (10,300-13,200)	See footnote (f).
SJ/SC RWF	103.2 (115,600)	18.1 (20,300)	0	85.1 (95,300)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA WWTP	6.5 (7,300)	2.8 (3,100)	0	3.7 (4,200)	N/A
Total, 2025[g]	**145.3 (162,700)**	**24.8 (27,900)**	**2.7-7.3 (3,000-8,200)**	**113.2–117.8 (126,700-131,800)**	
2035					
Palo Alto RWQCP	22.1 (24,700)	2.5 (2,800)	1.3-3.3[d] (1,500–3,700)	16.3-18.3 (18,200–20,400)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale WPCP	17.3 (19,400)	1.5 (1,700)	1.4-4.0[e] 1,600–4,500	11.8-14.4 (13,200-16,100)	See footnote (f).
SJ/SC RWF	107.4 (120,200)	21.5 (24,200)	0	85.9 (96,000)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA WWTP	6.5 (7,300)	3.3 (3,700)	0	3.2 (3,600)	N/A
Total, 2035[g]	**153.3 (171,600)**	**28.8 (32,400)**	**2.7-7.3 (3,000-8,200)**	**117.2-121.8 (131,000-136,200)**	

a. *Estimated based on 2015-2017 actuals and projected rate of increase from previous planning studies.*

b. *Calculated as available influent less the sum of 2015 UWMP NPR demand estimates, environmental flows, and other losses (such as in-plant process water losses).*

c. *Projected NPR demands do not fully capture potential allocations per contractual agreements. New agreements may be needed to access portion of available effluent for additional reuse. Governance considerations will be further evaluated as the Master Plan progresses.*

d. *Range reflects flow to Renzel Marsh currently included in the NPDES permit (1 mgd) and a high estimate (3 mgd), in case of a future expansion, along with an estimated 0.3-mgd loss of effluent used for in-plant processes (per Palo Alto's 2015 UWMP).*

e. *Range reflects current evaporation rates and higher estimate reserved for evaporation, capping, and other losses.*

f. *Per agreement between Sunnyvale and Valley Water, Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits. Valley Water and Sunnyvale meet annually to discuss the anticipated quantity of recycled water to be delivered through the Wolfe Road Pipeline to Valley Water customers.*

g. *Difference due to rounding.*

3.1.2 NPR/PR Split

Section 3.1.1 summarizes future plant influent, losses, environmental flow requirements, NPR demands, and the remaining effluent available (i.e., plant influent minus losses, environmental flows, and NPR demands). As discussed above, a portion of these flows are contractually obligated; making these flows available for countywide use would require new agreements. For the purpose of determining the reasonably available volume (based on projected usage), this analysis assumes NPR demands align with projections in the 2015 UWMPs. Governance considerations and potential new agreements will be further evaluated as the Master Plan progresses.

Flows available for additional reuse can be allocated as source water for either PR or additional NPR, or a combination of both. To estimate an initial NPR/PR split, NPR demands are assumed to increase per the future annual estimates in the 2015 UWMP prepared by each retailer, applied over the course of 1 year in accordance with the monthly distribution factors described in Table 3-2. Any remaining flows (minus potential flow required for discharge or blending) will be available as source water for PR (i.e., feed water for an AWPF). Examples of how this calculation presents the monthly flow for NPR and remaining effluent available from each treatment plant are presented on Figures 3-6 through 3-11. The average remaining effluent was identified for each facility, though this flow may not be available year-round. Additionally, flow projections may be further refined as new information (e.g., updated NPR demand projections) becomes available.

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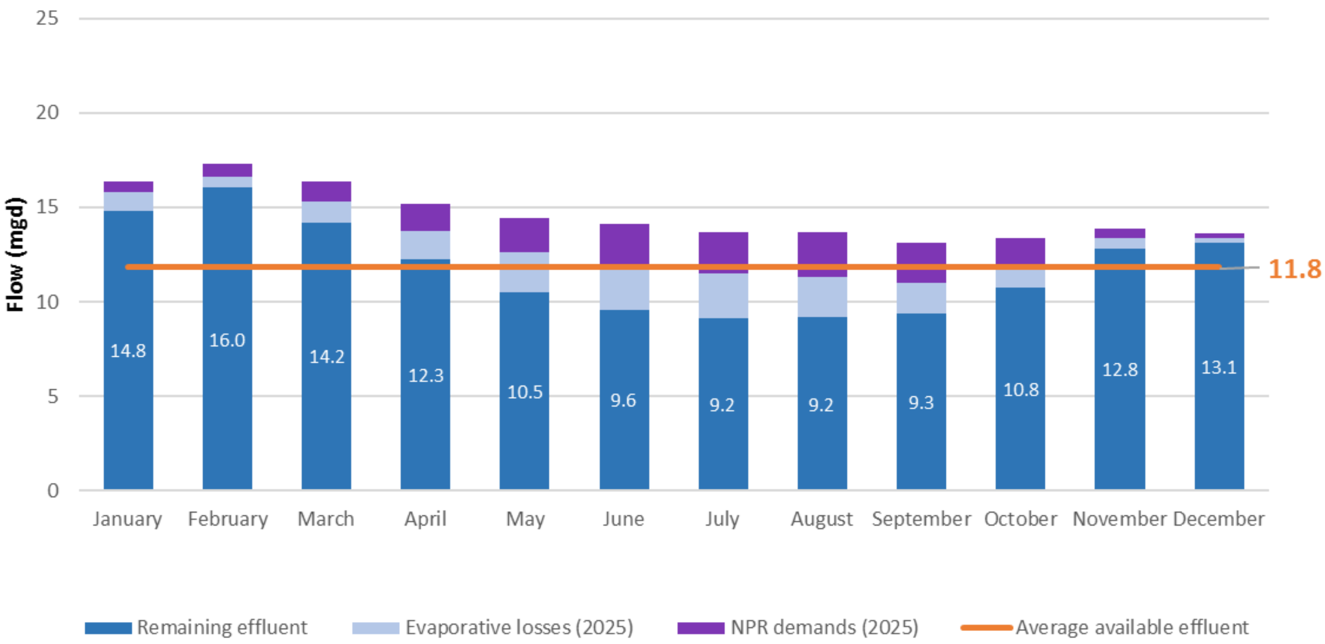

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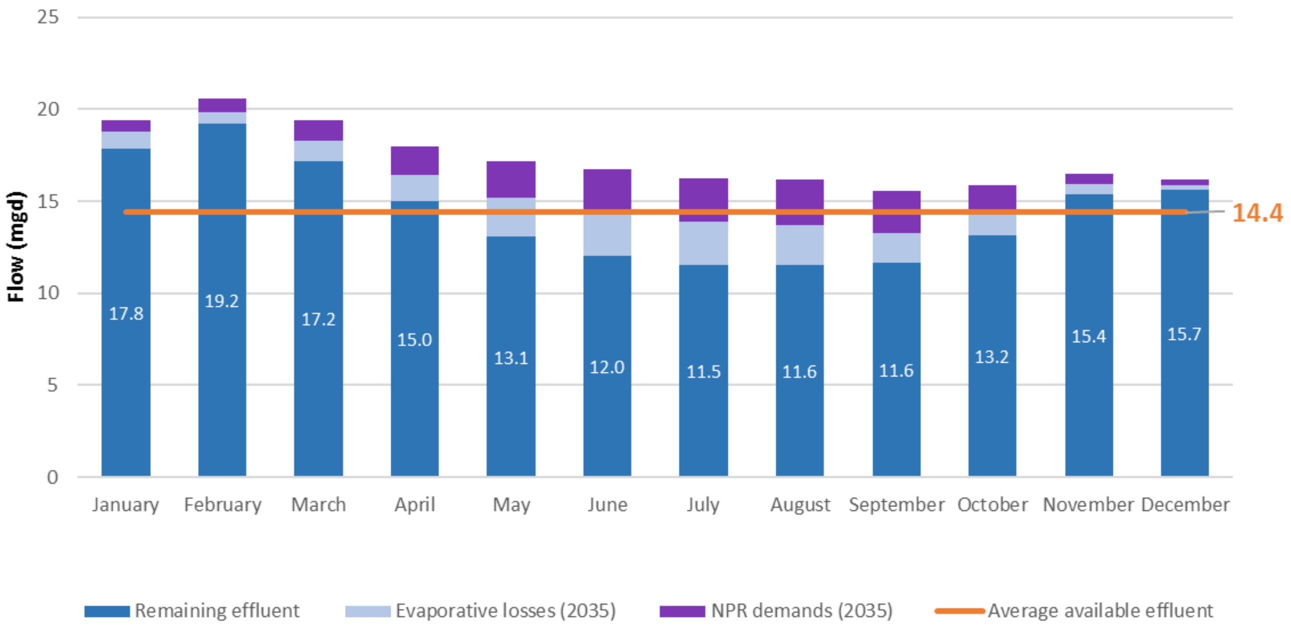

(b)

Figure 3-6. Sunnyvale WPCP: average plant influent, categorized by NPR demands, evaporative losses (based on current evaporation rates), and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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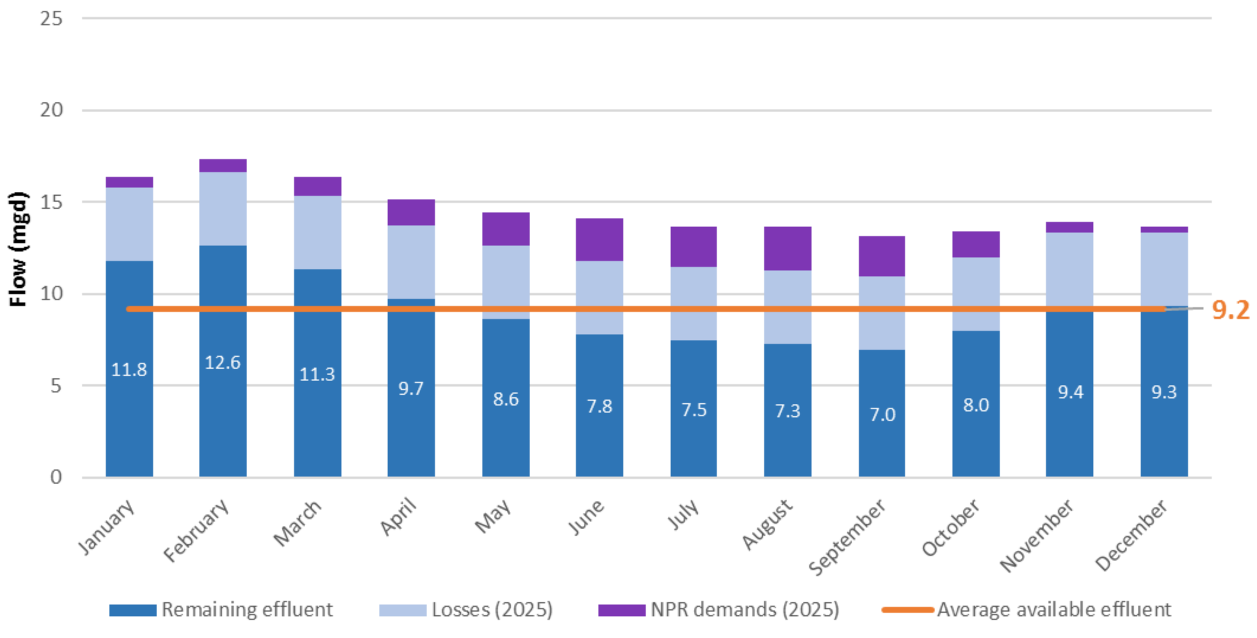

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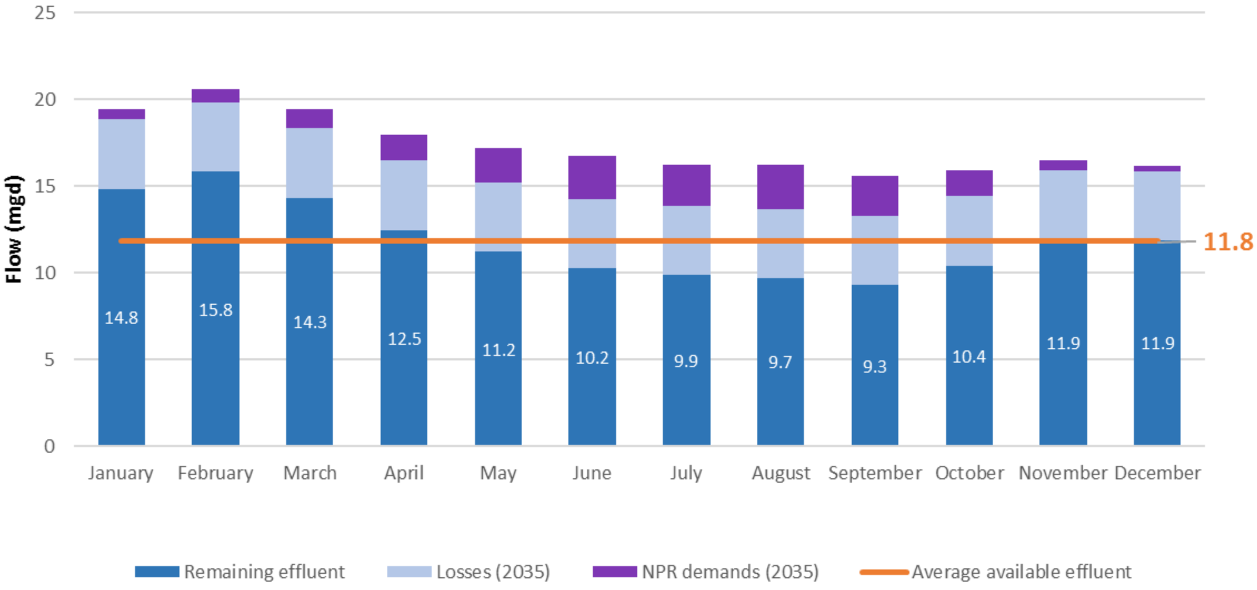

(b)

Figure 3-7. Sunnyvale WPCP: average plant influent, categorized by NPR demands, 4 mgd of evaporative and other losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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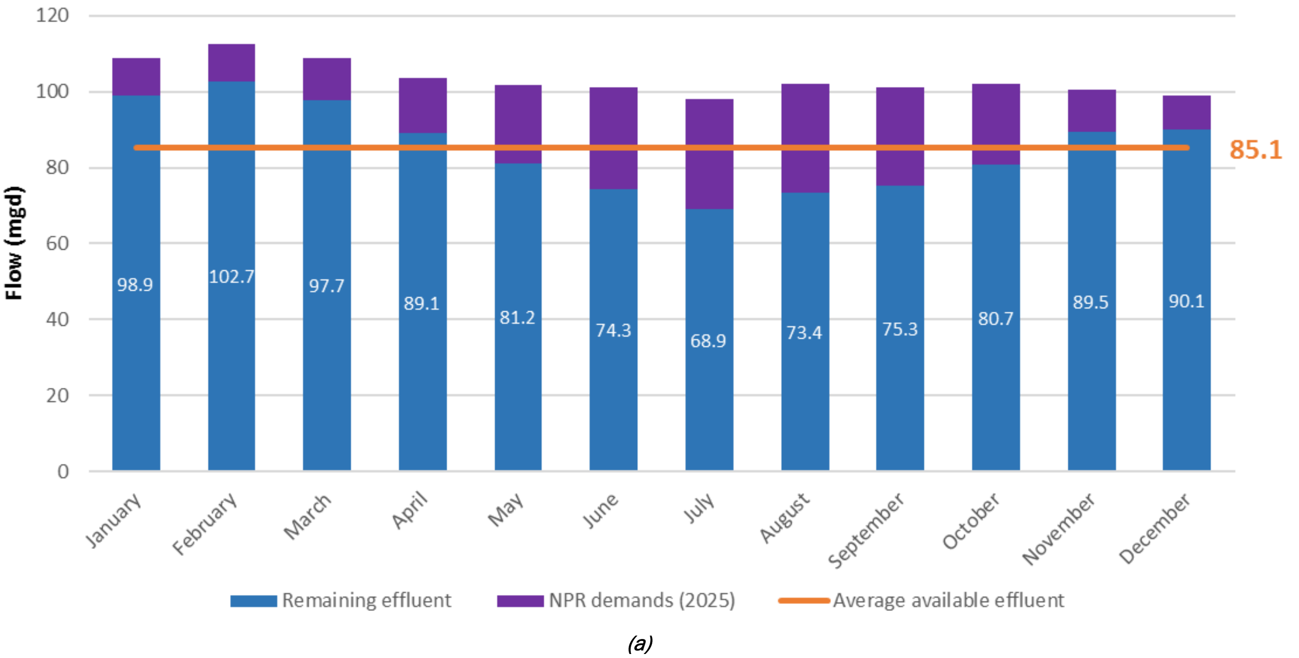

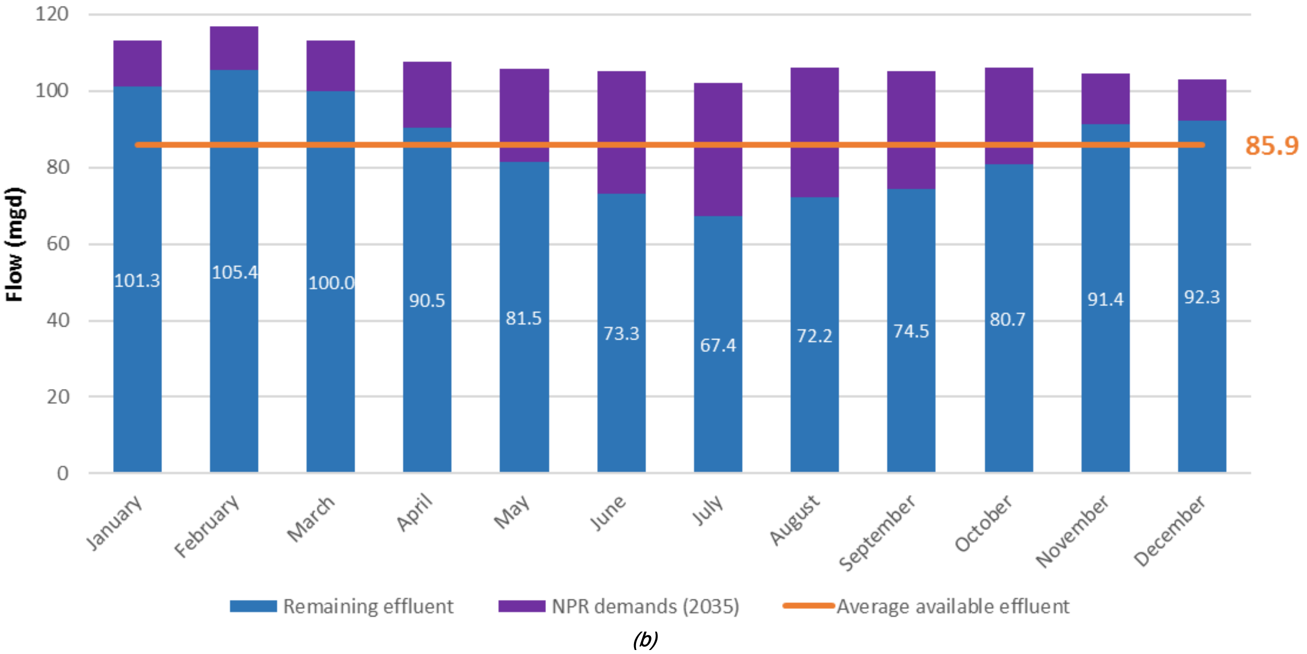

Figure 3-8. SJ/SC RWF: average plant influent, categorized by NPR demands and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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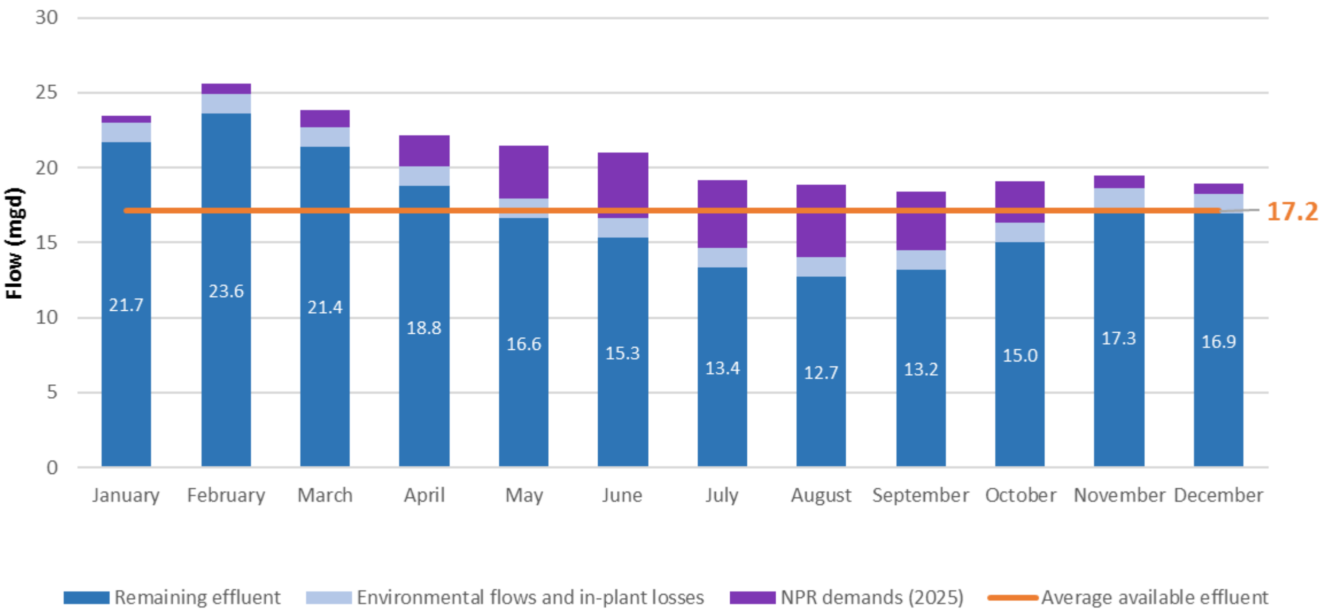

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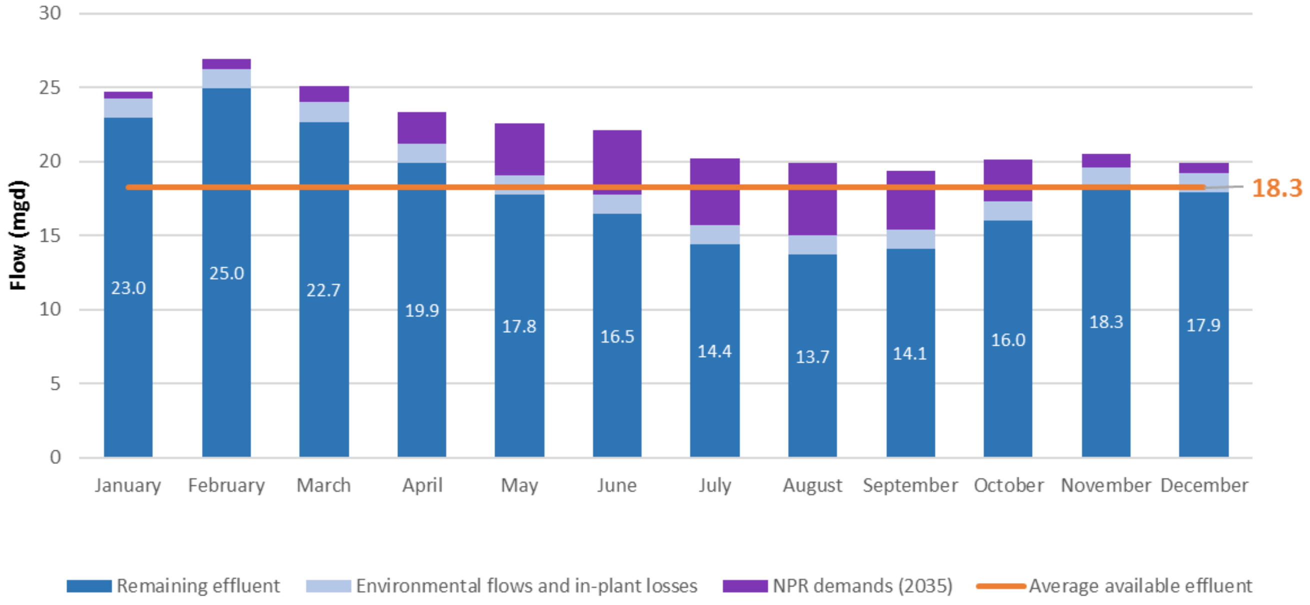

(b)

Figure 3-9. Palo Alto RWQCP: average plant influent, categorized by NPR demands, 1 mgd to Renzel Marsh, in-plant process water losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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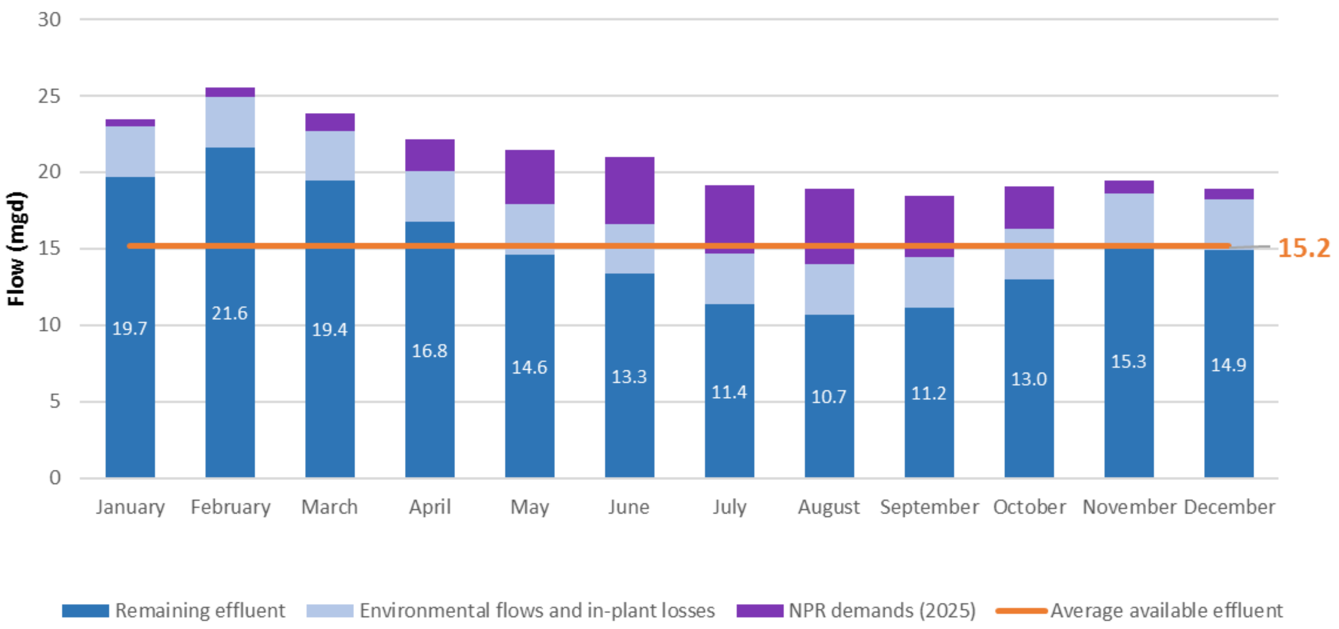

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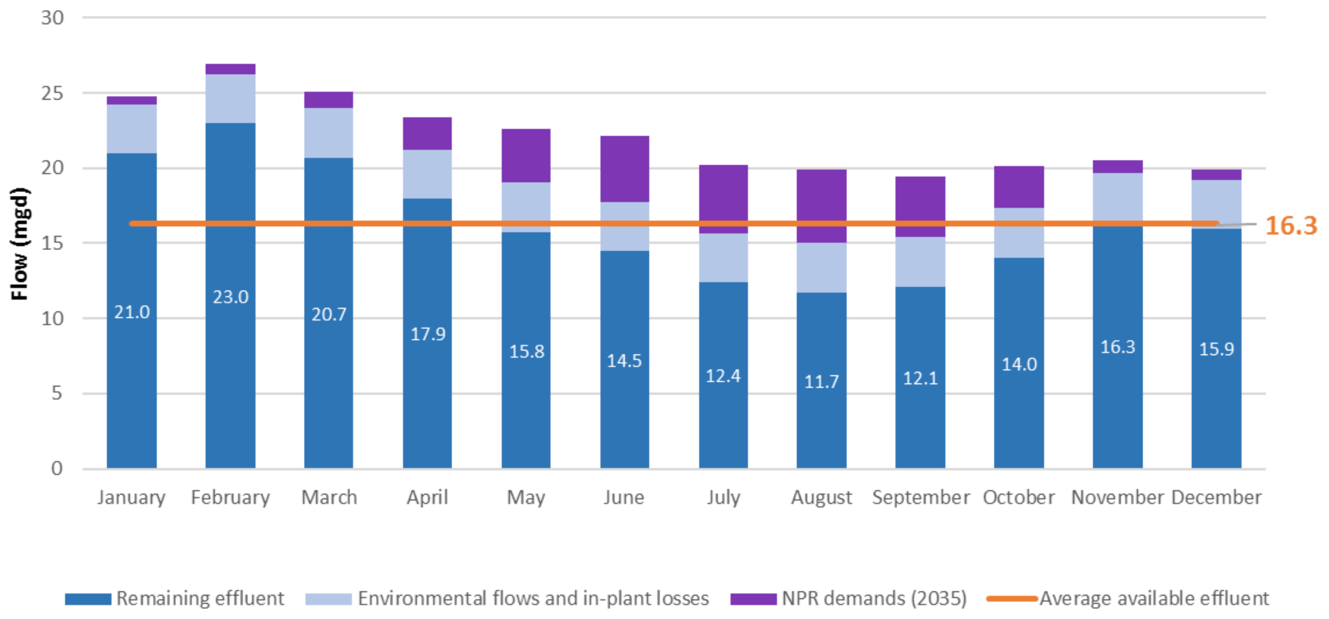

(b)

Figure 3-10. Palo Alto RWQCP: average plant influent, categorized by NPR demands, 3 mgd to Renzel Marsh, in-plant process water losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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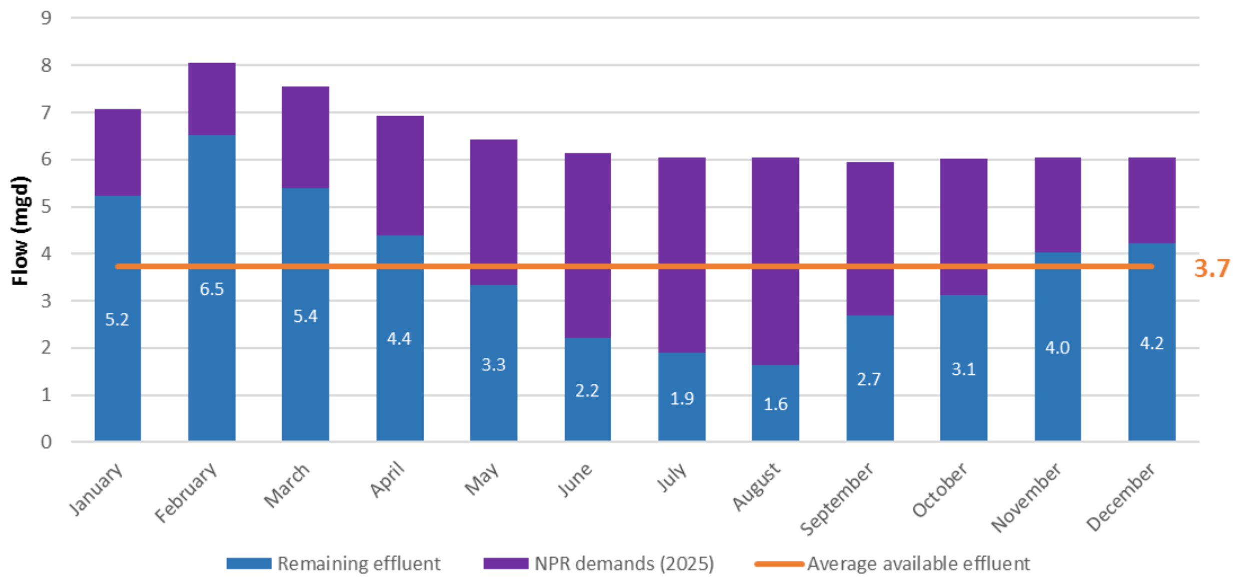

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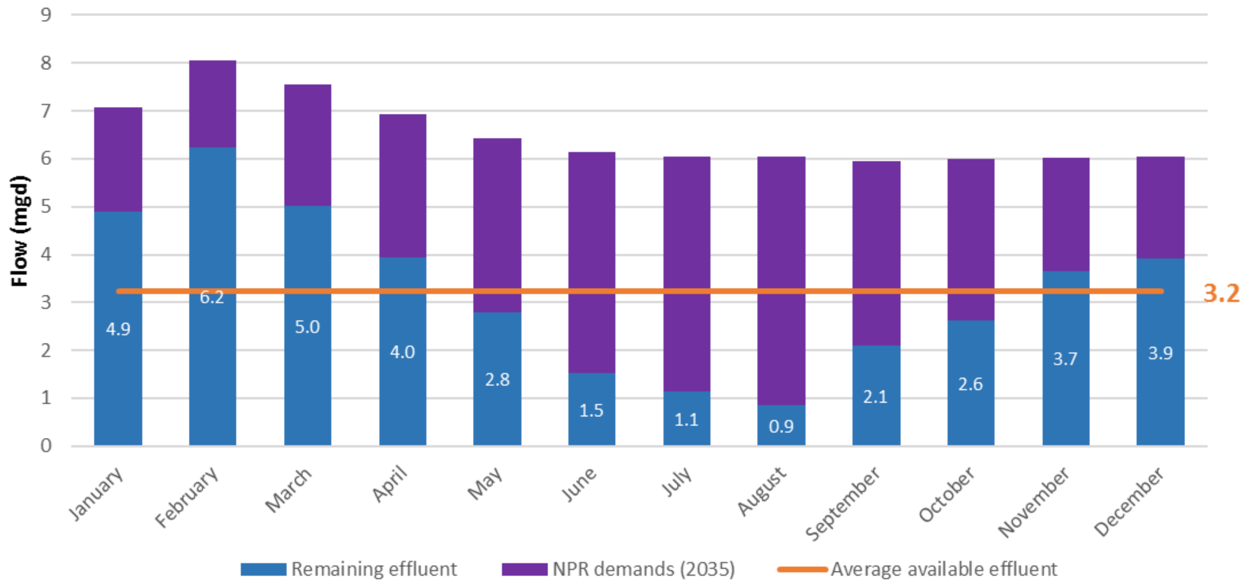

(b)

Figure 3-11. SCRWA WWTP: average plant influent, categorized by NPR demands and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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3.1.3 ROC Management Considerations

PR options that use RO-based treatment trains must manage ROC streams. Currently, the ROC from the 8-mgd SVAWPC is managed through the City of San José's outfall. If Valley Water expands RO-based treatment for PR, the increased ROC flows will present new challenges.

Currently, Valley Water is evaluating options for ROC management at the SVAWPC and at four other potential locations. ROC management options for the five locations were selected through a multi-criteria analysis method based on the following types of considerations: environmental, social, cost, engineering, and regulatory (Valley Water 2017a). In evaluating the options, copper, cyanide, nickel, and selenium were identified as the key water quality constituents for compliance.

The ROC management plan document also evaluated several past studies in the literature review, including reports on chronic toxicity and mass balance of the constituents of concern for NPDES compliance (Valley Water 2017a). The toxicity study found potential toxicity issues at higher ROC blend ratios (40 to 48 percent) and recommended additional testing to develop a larger baseline data set. The mass balance study identified several options to pursue if compliance became an issue, including:

- Reduce SVAWPC ROC production rates at low flow periods
- Seek dilution credit for key parameters
- Seek a water recycling credit
- Import flows from other plants or export ROC
- Treat ROC
- Beneficially reuse ROC in constructed wetlands

Hydrodynamic modeling and analysis of ROC discharge options is underway to evaluate ROC discharge at current publicly owned treatment works discharge locations and potential new outfall locations with more favorable dilution characteristics. This work is being performed in support of Valley Water's RO Concentrate Management Study by GHD. Another goal of this work is to apply a calibrated model to evaluate the ROC discharges into the lower South SF Bay in support of the regulatory process. The ROC management options that are being considered for the six potential AWPF sites are shown in Table 3-4. These options may be updated or expanded as conceptual alternatives are further defined.

Table 3-4. Short-listed ROC Management Options to be Further Considered (as of 2017)

AWPF Site	Options for Further Consideration		
Expanding SVAWPC	Effluent blending	Treatment cells	New shallow outfall
Sunnyvale	Treatment cells	Effluent blending	New shallow outfall with regional treatment
Palo Alto	Treatment cells	Effluent blending	New shallow outfall with regional treatment
Ford Ponds Satellite Facility	Sewer discharge	A mechanical/solidification option	
SCRWA	Evaporation ponds	Deep well injection	Connection to existing Watsonville ocean outfall
Regional AWPF	Treatment cells	New shallow outfall with regional treatment	Blending with existing East Bay Dischargers Authority outfall

Source: (Valley Water 2017a).

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Currently, both bench and pilot testing are being conducted to evaluate the benefits of ROC treatment (Mitch et al. 2017; Valley Water 2017b). These efforts are evaluating both engineered wetlands and oxidative pre-treatment to quantify these processes' ability to control a wide range of chemicals present in the ROC. Results from these efforts will be used to predict the impacts of the full-scale treatment on both water quality and habitat restoration. Ongoing experiments are evaluating two pilot-scale engineered wetlands at the SVAWPC site. The treatment cells comprise 300 square meters of wetland with a shallow water depth (0.3 meters) that provide 1 to 4 days of residence time; cells are evaluated regarding control of nutrients, trace organics, inorganics, and CECs/disinfection by-products (DBP). Another factor being evaluated is the impact of pretreatment with an oxidative process (both ozone- and UV-based processes).

3.2 Countywide Opportunities

Treatment facilities and distribution systems in the County have limitations, as discussed in Section 1.5. Several projects are under consideration that will expand the capacity and reliability of these existing systems.

3.2.1 Improvements via Interties

Interties connecting existing and potential NPR, IPR, and DPR systems can improve regional reliability and efficiency. A limited number of interties are currently in place, such as the connection between SBWR and the SVAWPC. Construction of additional interties will be considered as part of the conceptual alternatives development. Table 3-5 presents potential new interties that could improve supply reliability and resilience.

Table 3-5. Potential Interties to Increase Supply Reliability

From	To	Type
PA RWQCP	Sunnyvale WPCP	NPR
PA RWQCP	Sunnyvale WPCP	IPR
PA RWQCP	Los Gatos Ponds	IPR
PA RWQCP	Bay Division Pipeline	DPR
Sunnyvale WPCP	SBWR	NPR
Sunnyvale WPCP	Los Gatos Ponds	IPR
Sunnyvale WPCP	SVAWPC	IPR
Sunnyvale WPCP	PA RWQCP	DPR
SVAWPC	Los Gatos Ponds	IPR
SVAWPC	South Bay Aqueduct	DPR
SJ/SC RWF	Sunnyvale WPCP	NPR
SJ/SC RWF	Sunnyvale WPCP	IPR
SJ/SC RWF	SVAWPC	IPR
SCRWA WWTP	Santa Clara Conduit (via Scalping Plant)	DPR

3.2.2 Projected CIP Projects

This section reviews upcoming major CIP projects in the County related to wastewater treatment or recycled water production.

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3.2.2.1 PA/MV

The City of Palo Alto's 2012 Long Range Facilities Plan for the Regional Water Quality Control Plant identifies $315M to $392M in recommended upgrades over the next 50 years (City of Palo Alto 2012). Projects to be started before 2025 represent $165M to $242M and include:

- Upgrading solids handling
- Remodeling the laboratory and environmental services and operations buildings
- Replacing the headworks facility and grit removal system
- Replacing recycled water filters, chlorine contact tanks, and piping
- Rehabilitating:
    - Electrical/power support facilities
    - Primary sedimentation tank structure
    - Secondary clarifier
    - Dual-filter media
    - Fixed-film reactors
    - Sludge thickeners
    - Aeration basins

Palo Alto has prepared its Environmental Impact Report (EIR) (State Clearinghouse No. 2011062037, April 2015) for the Palo Alto Recycled Water project that will involve installation of two new pump stations and approximately 11 miles of 6-inch- to 18-inch-diameter pipeline (City of Palo Alto 2015). The new facilities will supply up to 900 AFY of recycled water for NPR.

Mountain View's proposed Whisman School Park/Central Expressway Alignment consists of approximately 36,000 LF of new pipeline and will serve an average day demand of 1,131 AFY. Project implementation is expected to be completed in phases, though exact timing is unknown.

Palo Alto and Mountain View, together with Valley Water, completed an Advanced Water Purification System Feasibility Study and are currently working on the Northwest County Recycled Water Strategic Plan. Both projects are in early planning stages, so costs and implementation schedules remain undetermined:

- **Advanced Water Purification System Feasibility Study:** Identified options to locate, at buildout, a 2.25-mgd AWPF, 3.0-MG permeate storage tank, and 2.41-MG recycled water storage tank on the RWQCP property. The intent was for purified water produced by the RWQCP to be used for NPR, with the concentrate discharge sent to the main RWQCP outfall for discharge to the SF Bay after blending with treated wastewater. The feasibility study also identified a location on the RWQCP site for a larger facility (6+ mgd) that could be used as a regional PR facility.
- **Northwest County Recycled Water Strategic Plan:** Expected completion 2019. This document is intended to clarify the groundwater sub-basin characteristics in the northwest portion of the County and how it interfaces with other areas, evaluate the feasibility of indirect PR as a groundwater management strategy, and establish a baseline to model potential impacts to groundwater under future use scenarios. This plan also evaluates RWQCP service area water reuse demands and expansion opportunities for increased PR and NPR in the service area. The intent is that the results of this document will integrate into this Master Plan once work is completed.

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3.2.2.2 Sunnyvale

In July 2016, Sunnyvale finalized an EIR (State Clearinghouse No. 2015062037) for the WPCP Master Plan (City of Sunnyvale 2013a). Plant upgrades proposed as part of the WPCP Master Plan include:

- Constructing new primary treatment facilities (currently in progress)
- Rehabilitating existing facilities
- Transitioning to conventional activated sludge
- Constructing a new filter control building and chloramine disinfection facilities
- Improving solids handling, including:
  - Thickening/dewatering
  - New digester
  - Fats, oils, and grease facility
  - Biosolids post-processing
- Remodeling administration and maintenance buildings
- Tidal flood protection
- Power, automation, and heating upgrades

Primary treatment upgrades are expected to be completed by late 2020, and secondary and tertiary treatment improvements will be completed by 2030. Implementation of the entire WPCP Master Plan is expected to be completed in 2042, and total costs are approximately $456M.

Sunnyvale's 2017 WPCP Recycled Water Annual Report does not list any upcoming distribution system improvements (City of Sunnyvale 2017). Following the completion of the Wolfe Road main, the focus for 2018 in terms of recycled water seems to be completing the continuous production upgrade at the WPCP and new customer signups. For completeness, full system expansion (as laid out in the 2013 Feasibility Study for Recycled Water Expansion Report) is described below.

The proposed pipeline extensions in the 2013 Feasibility Study for Recycled Water Expansion Report will meet a recycled water demand of 1.84 mgd (2,061 AFY). The study also recommends adding 5 MG of new recycled water storage at either the Wolfe-Evelyn or Central Avenue water plant sites (City of Sunnyvale 2013b). New pipeline and pumping, storage, and treatment improvements will be implemented in four phases, and total capital costs will be approximately $114M. The above recycled water demand and project cost totals include the Wolfe Road main (Phase 1 in the study). The remaining phases will deliver approximately 1.40 mgd (1,566 AFY) of recycled water and cost $83.1M.

3.2.2.3 SBWR

The following discussion summarizes CIP efforts in three areas: (1) the RWF, (2) the recycled distribution system, and (3) the SVAWPC/purified water system.

SJ/SC RWF. The 2013 Plant Master Plan estimates $1B in RWF improvements just to continue operating with existing equipment (SBWR 2013). Through 2040, the RWF expects improvements to cost $2B. The following improvement projects are scheduled to start by 2025:

- Headworks modifications
- Primary treatment upgrades
- Secondary treatment upgrades
- Filter upgrades

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- New UV disinfection facilities
- Sludge fine screening
- Digester improvements
- Thickening upgrades
- Solids dewatering
- Lagoons/drying upgrades
- Solids drying
- Heat and power generation upgrades
- Solar power and digester gas storage
- Plant electrical reliability upgrades
- Advanced process control and automation

Recycled Distribution System. Distribution system improvements are described in Valley Water's and SBWR's 2014 Strategic and Master Planning, which sets a target of increasing recycled water use to 25,000 AFY by 2025 and 35,000 AFY by 2035 (SBWR 2014). Meeting these goals requires pursuing multiple pathways, including both NPR and PR. The framework for expansion in the near term (2015–2020) included IPR (recharge at Ford Pond) and improving distribution system reliability, specifically:

- Increasing TPS capacity
- Conducting filtration and chlorination studies to improve production capacity
- Upgrading Pump Station 5 bypass
- Constructing Zone 1 storage
- Addressing condition-related deficiencies (Pump Station 5 variable-frequency drives; valves; heating, ventilation, and air conditioning systems)
- Updating automation and control strategies

The near-term reliability improvements are estimated to cost between $45M and $49M, while the Ford Pond IPR project was estimated to cost $64.4M. Beyond 2020, SBWR may expand the pipeline system and pursue additional IPR, including delivering purified water to both recharge ponds and injection wells as described in the Strategic and Master Planning Report. The estimated capital cost for expanding the recycled water distribution system, including pipelines, pump stations, and storage, is $243M. Long-term PR project costs will cost $522M. These PR numbers were further updated by the public-private partnership (P3) approach described below.

SVAWPC/Purified Water System. Valley Water developed the Draft Expedited Purified Water Program Plan (Program Plan) in February 2018 to build on and update the contents of the SBWR Strategic and Master Planning (SBWR 2014). The Program Plan assumed that all source water would originate from the SJ/SC RWF, and that the existing RWF outfall could accommodate ROC from an expanded SVAWPC. In addition, the Program Plan recommended an initial alternative of delivering at least 24,000 AFY of purified water to the Los Gatos Ponds by expanding the SVAWPC capacity by 24 mgd, and constructing a new 18-mile, 48-inch-diameter purified water pipeline between the SVAWPC and Los Gatos ponds through San José, Santa Clara, and Campbell.

This project is proposed to be implemented through a P3 approach, under which a private entity will finance, design, construct, and operate the project, and deliver purified water to Valley Water at the Los Gatos Ponds. Valley Water initiated a P3 process in 2016 and recently updated the process to qualify additional P3 teams. Multiple new agreements and studies will be required, as well as new permits. The total capital cost for this

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project is approximately $651M. The current schedule for next steps in the P3 process envisions putting the project into operation by 2025.

Neither the City of Santa Clara nor San José Municipal Water System are currently planning significant distribution system projects. While system expansion details for SJW and the City of Milpitas follow, related demands and costs are reflected in the aforementioned SBWR Strategic and Master Planning information (SBWR 2014).

SJW, which owns, operates, and maintains portions of the existing SBWR distribution system, plans to construct recycled water main extensions (Alignments D, E, Q, P, L, and K) through the year 2029. The new pipelines, combined with new customer signups on existing mains, are expected to increase recycled water demand by 5.72 mgd (6,405 AFY). Alignment D is complete, and Alignment E is tentatively planned to be constructed in 2021. Construction of the other alignments is contingent upon executing a wholesaler-retailer agreement amendment between SBWR and SJW, and California Public Utilities Commission approval.

In October 2016, the City of Milpitas adopted a California Environmental Quality Act (CEQA) document for its Recycled Water Pipeline Extension project. This project will result in the construction of five new recycled water projects totaling 50,560 LF of distribution pipeline, a 1.5-MG storage tank at Cardoza Park, four booster pump stations, and connection of up to 0.67 mgd (751 AFY) of demand. There is no known schedule to implement these projects. Total project costs are estimated to be $45M.

3.2.2.4 SCRWA

SCRWA and Valley Water released a South County Recycled Water Master Plan Update in 2016 that evaluates expansion alternatives and recommends a 20-year, $98M CIP to increase non-potable recycled water use by 9.2 mgd (10,305 AFY) and improve system reliability (SCRWA 2015). The CIP includes pipelines, storage tanks, pump stations, and WWTP upgrades. As mentioned in Section 1.5, SCRWA has already completed some of the recommended WWTP improvements, including installing a UV disinfection system and constructing a second clarifier. Remaining major CIP efforts include:

- Increasing capacity of Pump Station 93
- Installing a membrane treatment train to operate in parallel with oxidation ditches
- Upgrading the solids dewatering system
- Constructing a new recycled water storage tank

A portion (Phase 1B and 2A) of the recommended alignment is being constructed as part of Valley Water's South County Recycled Water Pipeline project. The new 14,500-LF pipeline will expand service to western Gilroy while providing approximately 2.77 mgd (3,100 AFY) of recycled water.

3.3 Considerations

Two major factors that must be considered when expanding NPR and developing PR are public perception and supply reliability.

3.3.1 Public Engagement and Perception

Valley Water has an active and engaged public outreach program to help build public acceptance of recycled water. This program includes multiple community surveys, tours of SVAWPC, creation of a new website (www.purewater4u.org), creation of marketing collateral material in multiple languages and formats, and a public listing of recycled water supporters. Valley Water's marketing efforts have been recognized with awards at both the state and local level. More recently, Valley Water convened the IAP to review recommended recycled water and purified water alternatives, and to help guide its public outreach efforts.

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Most water retailers have websites explaining recycled water production, delivery, and safety. Typically, customers who are already connected to recycled water will have undergone Site Supervisor Training to understand how to use recycled water in accordance with all guidelines. Additionally, they will be required to conform to all reporting and monitoring requirements promulgated by the permit in effect for their retailer. Each retailer also has various contacts for general questions, document submission, and emergency response. Additionally, each municipality has ordinances in their municipal code requiring the use of recycled water where available. Some municipalities also have ordinances requiring buildings within a specified area to be dual-plumbed for recycled water use for toilet and urinal flushing.

Unique elements of the public engagement and public perception process for each retailer are summarized below.

3.3.1.1 PA/MV

City of Mountain View ordinances require the use of recycled water for irrigation systems within the North Bayshore Area. All new developments must be designed to use recycled water for landscape irrigation. Mountain View has posted “Customer Guidelines for Recycled Water Use” to outline the process for establishing and maintaining a recycled water service connection.

As part of its Recycled Water Feasibility Study, Mountain View surveyed customer interest in using recycled water. Most customers who responded expressed interest in using recycled water for NPR purposes on their property, if it were available. In general, customer responses also supported the idea of using recycled water at their property.

In 20.15, Palo Alto completed the public review process and adopted the final EIR for the City of Palo Alto Recycled Water project. In 2019, completed its Northwest County Recycled Water Strategic Plan (NW County Plan) to more fully explore Palo Alto’s reuse options. The NW County Plan includes a public outreach task to recommend next steps for public engagement. Should the City of Palo Alto proceed with any reuse expansion projects, it would need to increase public engagement with potential customers and the community.

3.3.1.2 Sunnyvale

Sunnyvale developed a marketing plan for recycled water as part of the Feasibility Study for Recycled Water Expansion Report (City of Sunnyvale 2013b). This plan was intended to inform stakeholders about recycled water and obtain potential customers’ commitment to use recycled water. Sunnyvale also has multiple outreach avenues, including Sustainable Sunnyvale, focused websites relating to water supply and distribution, recycled water, and its ESD. Most of Sunnyvale’s customers have been using recycled water since the early 2000s. Current Sunnyvale efforts focus more on new construction, system modifications, changes in ownership, and answering general questions. Sunnyvale also has constructed a demonstration garden at Baylands Park to illustrate the impact of recycled water on typical landscaping.

Customer coordination related to the new Wolfe Road recycled water pipeline is the responsibility of Valley Water as the wholesaler and Cal Water as the retailer.

3.3.1.3 SBWR

With more than 20 years of experience operating recycled water systems, SBWR and its retailers have made recycled water use and knowledge more ubiquitous and familiar to customers within their service area. SBWR has a relatively robust public outreach program, as it delivers recycled water to more than 850 customers in its service area. The focus of SBWR’s outreach is on maintaining compliance with rules and regulations, collecting annual site inspection reports, providing Site Supervisor Training, coordinating review of new developments, and working with retailers to coordinate customer connections—particularly new developments.

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SBWR performs Site Supervisor Training workshops several times a year to focus on the importance of recycled water, the role of the site supervisor, present guidelines for recycled water use, and provide guidance on managing recycled water use on its property. Through 2017, more than 1,700 attendees have become registered as site supervisors.

The City of San José also adopted a "Green Vision," of which Goal 6 is to recycle or beneficially reuse 100 percent of its wastewater. Put into performance metrics, the City's goal is to use approximately 40 mgd of effluent by 2022. A key aspect of achieving this goal rests in the City's partnership with Valley Water to expand the SVAWPC.

3.3.1.4 SCRWA

A customer survey completed as part of the 2015 South County Recycled Water Master Plan Update surveyed 25 customers with questions intended to gauge their interest and feasibility of using recycled water (SCRWA 2015). Of the customers surveyed, all but two expressed interest in using recycled water. Future customers are expected to be generally accepting of using recycled water for non-potable purposes in Gilroy.

Currently, recycled water is provided to eight customers outside of the plant. These customers include various City of Gilroy facilities, a local farm, power plant, the Eagle Ridge Golf Course, and the McCarthy Business Park. Additional private and public customers are expected to use recycled water in the future when new pipelines are constructed. As the use of recycled water diversifies to more private uses, additional customer coordination and outreach will be required on an ongoing basis.

3.3.2 Source Water Reliability

The Bay Area Integrated Regional Water Management Plan identifies system components that may be vulnerable to climate change (Kennedy/Jenks 2013). Many of these vulnerabilities apply to County recycled water treatment and distribution facilities. For example, because a warmer climate means higher evaporation losses, water demand may increase; more variable and extreme precipitation will also highlight reliability deficiencies; and the WPCP and RWF require additional flood control structures to protect against sea level rise and tidal flooding.

An example of the reduction in source water reliability is illustrated in Figure 3-5 in Section 3.1.1, as ADWF projections from the PA/MV RWQCP 2012 Long Range Facilities Plan were much higher than 2015 – 2017 actual flows. Declining plant influent flows resulting from drought, climate change, and increased water use efficiency may impact the potential water available for reuse. The evaluation in Section 3.1 has incorporated adjustments to account for declining flows, though future plant influent trends may vary.

Section 4: Gap Analysis

Based on the information collected and reviewed, important considerations for potential alternatives have been identified and are discussed in this section. Table 4-1 presents a summary of recommendations from this gap analysis.

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Table 4-1. PR Gap Analysis Recommendations

Consideration	Recommendation	
	GWR	DPR
Treatment	• Additional testing to increase RO credits • Testing to evaluate UV/AOP (underway) • Additional testing will be necessary if Valley Water decides to pursue non-RO based groundwater spreading options	• Additional testing of ozone/BAF to improve dosing control and assess benefits for downstream processes and ROC management • Additional testing to increase RO credits • Testing to evaluate UV/AOP (underway) • Demonstration testing of DPR treatment train to gain experience with integration of high-frequency data collection
Source water quality	• Characterize potential source waters for key constituents (e.g., NDMA)	• Consider quality of feedwater needed for DPR (e.g., nitrified/denitrified, tertiary filtered) • Consider pathogen monitoring study at WWTP to obtain removal credits
Regulations	• No regulatory gaps: GWR regulations finalized in 2014	• DPR regulations not anticipated until 2023 • Consider potential additional requirements, e.g., treatment, monitoring, operations
Source control	• Begin coordination with wastewater provider to broaden source control program	
Groundwater characterization	• Characterize groundwater basin retention times through tracer studies • Characterize availability of diluent water for tertiary spreading • Continue characterizing water quality of existing basins	• N/A
Environmental discharge	• Evaluate compliance with Salt and Nutrient Management Plans and antidegradation regulations • Likely to be more challenging with GWR via tertiary spreading	• N/A
Source water availability	• Secure agreements with wastewater partners	
ROC management	• Continue evaluation of RO concentration management strategies • Coordinate with wastewater agency that will receive ROC	
Demand (water supply needs)	• Valley Water plans to complete the WSMP in coordination with this Master Plan.	
Utilization rate	• Valley Water plans to complete the WSMP in coordination with this Master Plan.	

4.1 Data Supporting Potable Reuse Regulatory Approval

Valley Water's Expedited Purified Water Program has considered a range of PR options, including both GWR and the raw water augmentation form of DPR to meet its goal of producing at least 24,000 AFY for potable use. Valley Water evaluated multiple AWPF locations, groundwater spreading and injection options, and surface water augmentation, and selected five alternatives for further consideration:

- **Alternative 1:** Expanded SVAWPC with groundwater spreading at Los Gatos Ponds
- **Alternative 2:** Expanded SVAWPC and injection wells near Los Gatos Ponds
- **Alternative 3:** Expanded SVAWPC and raw water augmentation into South Bay Aqueduct or Central Pipeline
- **Alternative 4:** Ford AWPF with groundwater spreading at Ford Ponds

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- **Alternative 5:** Ford AWPF with surface water augmentation at Calero Reservoir

In this analysis, Valley Water made three key assumptions about the source water, treatment, and ROC management:

- Expanded SVAWPC receives source water from SJ/SC RWF: the evaluation assumed that diverting effluent to SVAWPC from the existing outfall would not negatively impact the SF Bay environment or salt marsh
- FAT treatment used for all PR options: FAT treatment was assumed for all IPR scenarios—including groundwater spreading options—to protect the quality of the groundwater and for consistency with the approved Salt and Nutrient Management Plan and PR outreach conducted to date
- Existing SJ/SC RWF outfall can accommodate expanded ROC flows: this assumption was based on preliminary results from an ROC management study (GHD, 2017).

After conducting this analysis, Valley Water selected Alternative 1: Use 24 mgd from an expanded SVAWPC for groundwater spreading at Los Gatos Ponds. This effort provided a great deal of clarity on the feasibility and cost of a future PR option. Many assumptions were needed to complete this analysis; those assumptions require further refinement and are included in the gap analysis.

The Master Plan will incorporate these and other PR and NPR alternatives to meet Valley Water's goals. As a result, some of the assumptions of the Expedited Purified Water Program may be revisited.

The following gap analysis considers a wider scope of source waters, treatment trains, and PR options.

4.1.1 Groundwater Recharge

As described in Section 2, Valley Water has undertaken multiple efforts to demonstrate the effectiveness of the SVAWPC in complying with the regulations for GWR. This section describes recommendations for future efforts that will aid in designing and permitting a future groundwater injection or groundwater spreading project.

4.1.1.1 Treatment Considerations for Groundwater Injection

This sub-section summarizes project capacity, RO, UV/AOP, and AWPF source water.

Project Capacity. The IAP Panel Report from the 2017 meeting asked Valley Water to provide better clarity on the capacity of the PR project at startup, as well as specific information on scheduling and phasing the projects from startup through full buildout (Crook et al. 2017). Since that meeting, additional clarity has been obtained through the Expedited Purified Water Program. While a preferred pathway to 24,000 AFY has been identified, one outstanding question is how this project could be expanded up to a total of 45,000 AFY of purified water, should it be needed to meet future water supplies

RO. One of the key items to develop through the permitting process is the degree of pathogen removal credit (i.e., log removal values [LRVs]) assigned to each unit process. One process that has been potentially under-credited is RO; this stems largely from the lack of sensitivity of the surrogates used to verify log removal performance—electroconductivity and TOC. Using novel RO surrogates has been an important recent research theme in the industry, with multiple potential alternatives providing LRV credit beyond those typically assigned (e.g., TRASAR™ [a proprietary fluorescent dye produced by NALCO], strontium, other inorganic ions). For example, the City of San Diego is seeking to receive up to 3-log credit for RO using strontium as an alternative RO performance surrogate. Valley Water is pursuing plans to also test fluorescent dye-based surrogates to expand RO credit from approximately 1.5-log to 3-log or more.

UV/AOP. Initial UV/AOP pilot testing at SVAWPC demonstrated the ability of UV/H_2O_2 to meet the GWR requirements for AOP processes (Valley Water 2016). The testing also revealed that UV/chlorine could not

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meet the same requirements under the range of conditions tested. The UV/chlorine findings depart from those undertaken for Terminal Island, San Diego, and Padre Dam, suggesting that additional UV/chlorine testing may be warranted. To that end, Valley Water is conducting additional UV/AOP pilot testing to evaluate both UV/chlorine and UV/H_2O_2 (Sangines 2017). This study will evaluate a range of scenarios to assist in the selection and design criteria for a future AOP process (UV dose, oxidant selection and concentration, chemical reduction performance), and complement previous UV/AOP pilot testing.

AWPF Source Water. One key item for the Master Plan is to identify the source water that will feed the future AWPF. If SVAWPC continues to receive effluent from SJ/SC RWF, it will be important to identify what degree of treatment is provided prior to the AWPC. There are advantages to using tertiary disinfected effluents as the AWPF feedwater. Recently, the City of San José has evaluated a sequential chlorination process that combines a short *free* chlorine CT (product of chlorine residual [C] and contact time [T]) followed by a longer *chloramine* CT. This process offers many advantages, including: (a) a high degree of virus inactivation (greater than 5-log); (b) effective coliform control; and (c) minimization of trihalomethane, haloacetic acid, and NDMA formation. One known issue with the FAT train is that it alone does not provide sufficient credits to meet the 12-log virus reduction requirement of the GWR regulations. Using a sequentially chlorinated feedwater will provide an additional 5-log virus credit while helping to control DBP formation. Further, filtered effluents provide an added layer of protection and water quality stability for the downstream AWPF. Filtration offers several benefits, including:

- Providing an added barrier against particulate matter (e.g., secondary clarifier upsets)
- Preventing the passage of organisms that can impact the performance of membrane processes (e.g., the blinding of pre-screens on MF processes)
- Enhancing membrane performance by providing additional turbidity and solids removal

One outstanding water quality issue identified in the 2016 Test Plan report was a high degree of variability in NDMA levels (Valley Water 2016). Regardless of the source water selected, it will be important to fully characterize the NDMA present in the water to ensure that the UV/AOP system is designed to reduce the levels below the notification level.

4.1.1.2 Treatment Considerations for Groundwater Spreading

Ozone/BAF-treated water was evaluated through pilot testing at the SVAWPC. Several issues were identified through ozone/BAF pilot testing that must be resolved before considering this option. The treated effluents could not meet the requirements for a few water quality parameters including TOC, NDMA, and nitrate. In spreading projects, both the aboveground treatment and SAT can be used to comply with the treatment and water quality criteria. One way to gain a better understanding of SAT's ability to further treat the ozone/BAF-treated effluents is through soil column testing. We recommend performing a soil column study to understand the feasibility of a spreading project and identify what additional treatment or other steps are required to meet the criteria.

Additional ozone testing would also be useful to gain operational experience with the dosing control system. During pilot testing, various factors impacted the ability of the ozone dosing system to provide a consistent ozone concentration (e.g., the presence of chlorine residual in the ozone feedwater). Gaining additional experience with O&M of the ozone/BAF system will also be useful for the design of the future full-scale system.

Ozone has been used in recycled water settings to provide disinfection in compliance with the Title 22 recycled water regulations. To date, a handful of recycled water facilities have received approval from the California State Board's DDW for ozone disinfection using the CT framework that is common in drinking and recycled water settings. One alternative crediting scheme that was evaluated during pilot testing was using the ozone-to-TOC ratio instead of ozone CT (Valley Water 2016). While this is an attractive option to reduce

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the operational costs of the ozone process, DDW has not yet permitted a facility using this crediting framework. The feasibility of this approach remains uncertain, but it is likely that securing this approval will require extensive dialogue with DDW and potentially additional testing.

In addition to resolving these technical issues, there are other considerations associated with the use of a non-RO based treatment train for groundwater spreading. These include compliance with the Salt and Nutrient Management Plan and Antidegradation requirements, as well as public outreach efforts. Valley Water will need to further study these issues if they decide to pursue a non-RO based treatment train for spreading.

4.1.1.3 Source Control

As described in the Regulatory Compliance Strategy Technical Memorandum (TM), the requirements for source control are significantly more stringent in PR settings. This stems from the fact that source control expands beyond environmental protection to also include public health protection. Significant coordination with the wastewater provider would likely be required as the scope of their source control program broadens.

4.1.1.4 Groundwater Characterization

One of the key elements for permitting GWR projects is demonstrating sufficient response retention times in the aquifer (see the Regulatory Compliance Strategy TM). Valley Water has updated its groundwater model to characterize the capacity and retention times of the proposed basins (see Section 2.4.1). Per regulations, numerical modeling must be followed by either an added or intrinsic tracer (see the Regulatory Compliance Strategy TM), as these latter options provide greater accuracy in estimating aquifer retention time.

Beyond characterizing retention time, spreading projects using tertiary-treated water will also require significant levels of diluent water. The recent groundwater modeling results looked at the percent contribution of purified water in potable supply wells in several locations. At the potable supply wells receiving percolated pond water from the Los Gatos Ponds, the Recycled Water Contribution (RWC, see the Regulatory Compliance Strategy TM) is 38 percent (Todd Groundwater, 2017b). For this RWC to be sufficient for regulatory compliance for tertiary spreading, the TOC would have to be 1.3 mg/L. Pilot testing demonstrated that ozone/BAF lowered the TOC to between 2 and 7 mg/L. Given this constraint, the capacity of a tertiary spreading project is likely to be limited by the diluent water available. Further characterizing diluent water availability will be critical to identify the capacity and feasibility of a GWR project via spreading of tertiary effluents.

Valley Water has historically carried out a rigorous water quality monitoring plan to characterize and protect the quality of its groundwater basins. DDW has additional monitoring requirements for GWR projects to further characterize the receiving water quality and to provide an early warning of any potential degradation in groundwater quality. Valley Water is currently undertaking this monitoring program in accordance with DDW requirements (Todd Groundwater, 2017c). The results of this monitoring will be useful in demonstrating compliance with DDW and environmental regulations, including the salt and nutrient management plans and anti-degradation requirements.

4.1.1.5 Source Water Availability

To date, Valley Water has developed MOUs with multiple regional partners. Securing an MOU with the City of San José is an next important step. The Master Plan will provide information to help understand the availability of resources to pursue both recycled (non-potable) and purified (potable) water options. An MOU with San Jose is important not only for source water availability, but also to coordinate other elements of the program, including source control and ROC management. Potential terms for the purified water MOU were presented at the 2017 IAP meeting (Table 4-2).

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Table 4-2. Potential Terms for Purified Water MOU with CSJ

Issues	Valley Water Proposal
Land	25+ acres
Treated wastewater	~30 mgd initially
Wastewater quality	Secondary or tertiary
ROC	~6 mgd

Source: (Ashktorab 2017).

4.1.1.6 ROC Management

Valley Water continues to evaluate options for ROC management. In addition to the technical questions identified in Section 3.1.3, this topic will also require coordination with the wastewater agency that will receive the concentrate. This is key because the ROC discharges must comply with the wastewater agency's NPDES permit. Other details to negotiate include how Valley Water will share liability with the wastewater agency for compliance, how it will coordinate compliance testing (e.g., toxicity testing), and how it interacts with the Regional Water Quality Control Board (RWQCB) (Daniel 2017). Assuming that the future project will include partnering with the City of San José, the IAP recommended that Valley Water and the City consult with the RWQCB executive officer to jointly work out an approach for ROC management (Crook et al. 2017).

4.1.1.7 Demand (Water Supply Needs)

Valley Water plans to complete the WSMP in coordination with this Master Plan. The WSMP will describe new water supply investments Valley Water is planning to make (such as storage), the anticipated schedule, and the associated costs and benefits. The Master Plan identifies the water available for PR and alternatives for future development, contingency planning, and regional efficiencies, such as interties.

4.1.1.8 Utilization Rate

Component economics are also a function of utilization rate, which is the estimated long-term average annual yield divided by the maximum annual yield. The utilization rate is impacted by hydrologic conditions, groundwater levels, water demand, and water supply policy or prioritization decisions (RMC, 2018).

4.1.2 Direct Potable Reuse

Valley Water is also interested in exploring options to implement DPR. Motivations for this pursuit include lower infrastructure requirements (e.g., pipelines, injection wells), simpler operations, and its ability to capitalize on existing facilities. This sub-section identifies outstanding issues that require further clarification or study to pursue DPR.

4.1.2.1 Regulatory Considerations for DPR

The most significant hurdle to the pursuit of a DPR project is the lack of regulatory certainty around how both forms of DPR (raw water augmentation and treated water augmentation) will be permitted. Regulations for both forms of DPR are being developed and are anticipated by December 2023. The Regulatory Compliance Strategy TM describes anticipated elements of future DPR regulations based on recent publications from DDW and the California DPR Expert Panel. One significant unknown is the level of treatment required for DPR projects, including future pathogen log removal requirements. To date, Valley Water has tested a pilot ozone/BAF system as potential pretreatment for a downstream FAT train. This train has been evaluated in previous testing and shown to provide a reliable degree of performance for DPR (Pecson et al. 2017). This train was also identified by the California DPR Expert Panel as a potential future option for DPR (State Water

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Resources Control Board 2016). Greater clarity on the minimum requirements for DPR—and the suitability of the ozone/BAF/MF/RO/UV-AOP treatment train—should be available by 2023.

4.1.2.2 Treatment Considerations for DPR

This sub-section summarizes several treatment considerations, including ozone/BAF, RO and UV/AOP, data integration and control, and AWPF source water.

Ozone/BAF. Valley Water has gained valuable experience with ozone/BAF process through previous piloting work. Additional ozone/BAF testing may benefit the permitting of a future DPR system in the following ways.

- Evaluating ozone control systems: One finding from the ozone/BAF pilot testing was that ozone dosing control was difficult to achieve due to several potential factors. Additional testing will allow Valley Water to evaluate different monitoring and control systems, gain additional proficiency with the process, and use that information to help inform a potential future full-scale facility.
- Assessing the impact on downstream processes: Incorporating ozone/BAF into a FAT train provides numerous benefits, including enhanced performance of the downstream MF/ultrafiltration (UF) and RO processes. For example, the City of San Diego has been able to design its future full-scale UF systems with significantly higher flux rates as a result of ozone/BAF pretreatment. The City of San Diego's ability to make this decision stemmed from its extensive demonstration testing, which included an assessment of membrane performance. Additional benefits of ozone/BAF include longer intervals between membrane cleanings and cleans-in-place, decreased backwash frequency, and reduced dependence on chloramines for performance.
- Evaluating benefits for ROC: Ongoing work on ROC management is evaluating several options including ROC treatment (Mitch et al. 2017). The ROC ozone treatment option is challenging due to the difficulty of introducing sufficient ozone into the high-TOC ROC stream. Applying ozone to the AWPF feedwater (instead of the ROC) would use similar amounts of ozone overall, assuming that the ozone is applied in proportion to the TOC in the water being treated. At this location, however, the ozone will provide numerous benefits in terms of disinfection, chemical control, and membrane performance. Further, reducing the level of toxic contaminants in the RO feed will also reduce the concentrations in the ROC, and may reduce the need for downstream ROC treatment.

RO and UV/AOP. The same considerations discussed in Section 4.1.1 related to the RO and UV/AOP systems also apply for DPR.

Data Integration and Control. One of the challenges of PR systems that do not use an environmental buffer is the loss of time to respond to issues that might impact the quality of the water. Consequently, DPR systems will likely be forced to meet more stringent requirements for process monitoring and control than GWR systems. One major challenge will be integrating the numerous monitors that measure process performance and developing control systems that can use this information to rapidly make decisions. This knowledge gap has been identified by the Water Research Foundation as a potential high-priority topic for DPR. Demonstration DPR treatment train testing will allow Valley Water to gain experience with integrating high-frequency data and developing rapid and reliable control systems, while demonstrating to DDW its ability to operate a complex and highly engineered treatment system.

AWPF Source Water. The level of treatment that will be required for source waters to DPR facilities remains uncertain, though the DPR Expert Panel recommended that high-quality source waters will further ensure the reliability of the downstream AWPF. The DPR Expert Panel recommended that DPR facilities receive source waters that have undergone both biological nutrient removal (e.g., nitrification/denitrification) and tertiary filtration (State Water Resources Control Board 2016). This recommendation is in line with previous DPR guidance (Tchobanoglous et al. 2015).

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Another priority DPR research topic is characterizing pathogen concentrations in raw wastewater and their reduction through WWTPs. To date, numerous IPR projects have sought and gained pathogen log removal credits through WWTPs. As the industry gains a better understanding of the factors influencing pathogen removal through WWTPs, site-specific studies are anticipated to be required for pathogen crediting (instead of relying on literature values). Given the high degree of biological treatment and filtration provided at the SJ/SC RWF, it is likely that pathogen LRVs can be demonstrated through tertiary treatment. These credits are essentially free because they are associated with an existing process. These would apply toward the overall pathogen reduction requirements and offset the need for additional treatment barriers.

4.1.2.3 Source Control

The same source control considerations discussed in Section 4.1.1 will also apply in DPR settings. Source control is one of the six priority research topics being pursued by California to inform future DPR regulations. Accordingly, new recommendations for DPR source control should be forthcoming; DPR source control requirements are anticipated to be more robust than IPR source control programs.

4.1.2.4 Source Water Availability

The same source water availability considerations discussed in Section 4.1.1 will also apply in DPR settings.

4.1.2.5 ROC Management

The same ROC management considerations discussed in Section 4.1.1 will also apply in DPR settings.

4.2 Project Requirements

Project requirements will vary widely depending on the project alternative(s) selected. Key considerations will include:

- Updates to NPDES permits, such as petitions to change in place of use
- Modifications to recycled water permits, tentative orders, etc.
- Assessment of pipeline alignments, right-of-way requirements, easements and construction impacts
- Determination of environmental report requirements, including potential flows for environmental benefit
- Thorough evaluation of the system receiving PR water, such as the groundwater basin or distribution system
- Comprehensive identification of facilities needed, including land acquisition, capital, and O&M costs

4.3 Resource Gaps

Recycled water facilities contain treatment processes that are familiar to water and wastewater operators. PR facilities incorporate advanced treatment processes with specific actions or monitoring (e.g., critical control points) that may require additional training and certification. The California Water Environment Association, in collaboration with California-Nevada Section of the American Water Works Association, is developing a training and certification program for advanced water treatment operators. While the details of the program are still in development, this type of training and certification will be applicable to potential PR alternatives.

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Appendix E-2: Recycle Hill Geotechnical Preliminary Study

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Technical Memorandum

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC internal)

Contract no.: A4120A

Appendix E-2

Subject: Geotechnical Preliminary Study: Recycle Hill

Date: July 13, 2018; reissued June 30, 2020

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Limitations:

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List of Abbreviations

1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
µg	microgram(s)
af	artificial fill
BAAQMD	Bay Area Air Quality Management District
BCDC	San Francisco Bay Conservation and Development District
BOD	biochemical oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylene
CAP	Corrective Action Program
CCR	California Code of Regulations
CGS	California Geological Survey
COD	chemical oxygen demand
CPT	cone penetration test
EPA	U.S. Environmental Protection Agency
ft	foot/feet
GEP	Geotechnical Exploration Plan
GTM	Geotechnical Study Technical Memorandum
LGMP	Leachate and Groundwater Management Plan
LUST	leaking underground storage tank
MCL	maximum contaminant level
MHHW	mean higher high water
MSW	municipal solid waste
MTBE	methyl tert-butyl ether
M_w	maximum moment magnitude
NA	not applicable
NAVD88	North American Vertical Datum of 1988
ND	not detected
PCE	tetrachloroethene
PEL	permissible exposure limit
Obm	Bay Mud
Ohb	basin deposits
RWQCB	Regional Water Quality Control Board
SCI	Subsurface Consultants, Inc.
SCS	SCS Engineers
SMR	Self-Monitoring Report
TCE	trichloroethene
UCERF 2	Uniform California Earthquake Rupture Forecast, Version 2
Ulrick	Ulrick & Associates
USGS	United States Geological Survey
Valley Water	Santa Clara Valley Water District
VOC	volatile organic compound
Water Board	State Water Resources Control Board
WPCP	water pollution control plant
WGCEP	Working Group on California Earthquake Probabilities

Section 1: Introduction

This Geotechnical Preliminary Study Technical Memorandum (GTM) presents a discussion of geologic, geotechnical, and environmental conditions at a project site being considered for a recycled water treatment facility. The project site is generally known as Recycle Hill and is one of four closed areas within the City of Sunnyvale municipal solid waste (MSW) landfill, located directly south of the Sunnyvale Water Pollution Control Plant (WPCP). The City of Sunnyvale is the owner and operator of record for the Sunnyvale Landfill and currently monitors the landfill under the Sunnyvale Landfill Postclosure Maintenance Plan (SCS 2012). The discussions, interpretations, and conclusions presented in this GTM are intended to support a feasibility assessment and the planning required to proceed with the siting, design, and construction of new facilities for a recycled water treatment plant near West Caribbean Drive and Borregas Avenue in Sunnyvale, California, as shown on Figure 1-1.

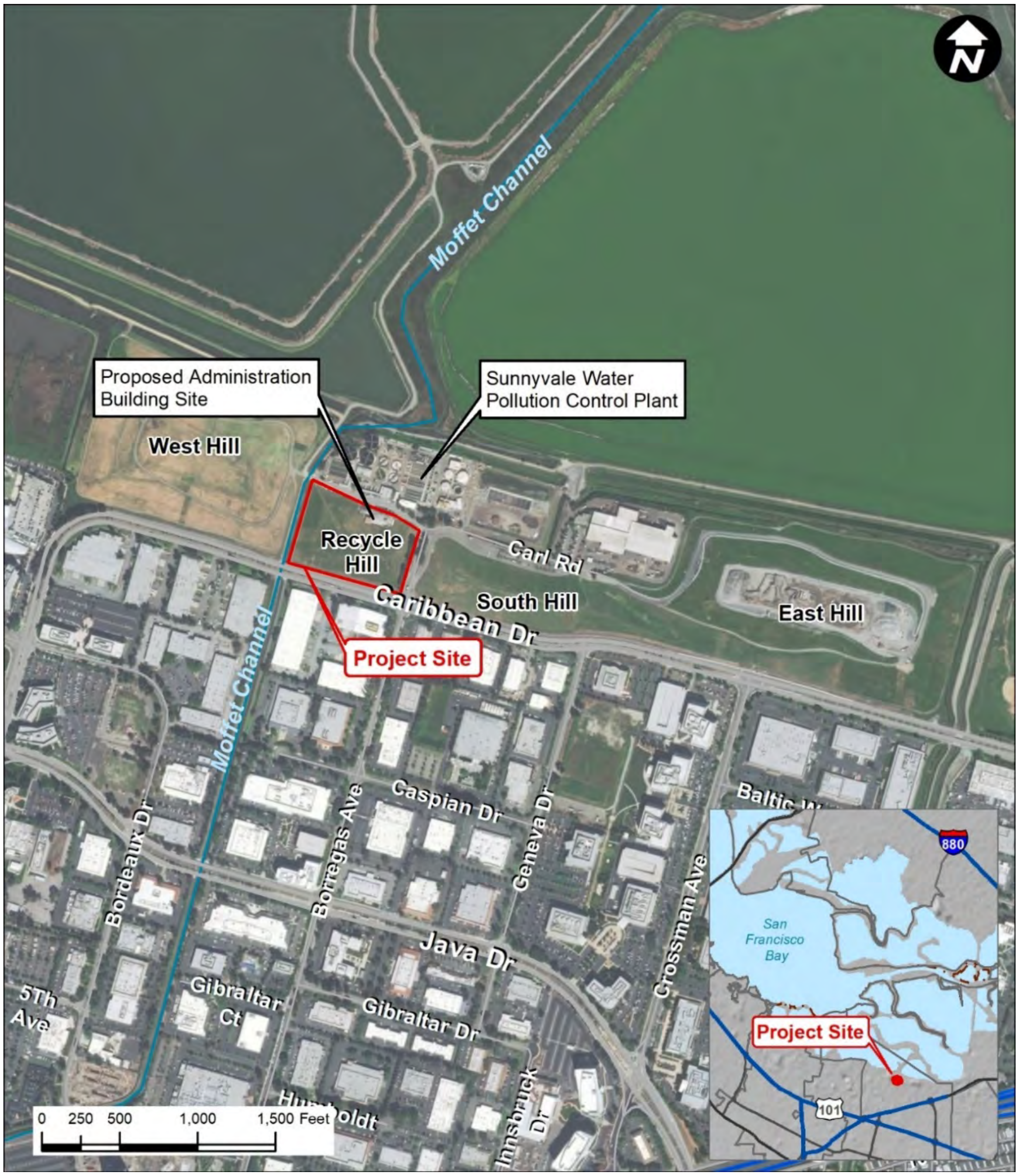


Figure 1-1. Site location map

1.1 Background and Scope

The purpose of this GTM is to review available geologic, geotechnical, and geoenvironmental information to support a feasibility assessment to use the project site for constructing a new recycled water treatment plant after the landfill waste is removed. This GTM is general in nature and is not intended for the analysis, design, and construction of new buildings and facilities at the proposed treatment plant site. Geotechnical interpretations for the project include:

- an overview of the regional geologic and seismic setting
- generalized discussion of the subsurface soil and groundwater conditions
- an assessment of geologic hazards
- assessment of geoenvironmental conditions related to soil and groundwater contamination below and adjacent to the closed landfill.

In May 2018, a geotechnical engineer completed a site reconnaissance around Recycle Hill and by walking on the mound slopes to note the overall slope condition and evidence of creep, slope failure, or erosion.

Geotechnical conditions are presented to discuss general considerations for the design and construction of possible foundation schemes. Geotechnical recommendations for final design should be based on a detailed geotechnical investigation, laboratory testing program, and geotechnical analysis that more specifically addresses preliminary layouts of treatment plant facilities.

Geoenvironmental conditions are presented to identify the known soil and groundwater conditions related to the release of hazardous materials into the environment and how those releases could impact the future development of Recycle Hill.

1.1.1 Geotechnical and Geologic Data Review

The team prepared and submitted a data request to the Santa Clara Valley Water District (Valley Water) and the City of Sunnyvale. The data requested and received are summarized in Attachment A.

Two sets of geotechnical borings drilled for earlier investigations at the proposed WPCP administration building site were reviewed for the preparation of this GTM. The boring logs were included in a work plan for a new geotechnical investigation for the proposed administration building (Geosyntec 2017) and in the geotechnical study for new improvements at the WPCP (Fugro 2016). These reports provided seven geotechnical borings as performed by Subsurface Consultants, Inc. (SCI 1992) and Fugro Consultants, Inc., (Fugro 2016) that are near the proposed recycled water treatment plant site. These seven borings and the proposed administration building site are located at the north edge of the proposed recycled water plant site (Figure 1-1). A summary of the borings is presented in Table 1-1.

Table 1-1. Summary of Reviewed Geotechnical Borings

Boring[a]	Date Drilled	Approximate Ground Surface Elevation (ft)	Approximate Depth to Bottom of Boring[b] (ft)	Approximate Depth to Groundwater[b] (ft)	Approximate Depth to Top of Observed Refuse (ft)[b]	Approximate Depth to Bottom of Observed Refuse[ab] (ft)
TB-6	July 1992	3.3[c]	31	12	2.5	11.5
TB-7	July 1992	3.3[c]	31	14	8.5	16.0
TB-8	July 1992	3.7[c]	31	12	0	16.5
TB-10	July 1992	3.8[c]	101	14	NA	NA
B-12	October 2014	107.0 +/-[d]	51.5	12.5	2.5	11.0
B-13	October 2014	107.0 +/-[d]	101.5	13.0	2.5	14.0
B-14	October 2014	106.0 +/-[d]	51.5	Not observed	2.5	6.5

a. Borings TB-6 through TB-10 from SCI 1992; borings B-12 through B-14 from Fugro 2016.

b. Depths given as measured from existing ground surface at time of drilling.

c. The exact elevation datum used on reviewed SCI boring logs is unknown.

d. Datum noted on Fugro boring logs is assumed to be NAVD88 +100 feet, as is common practice at locations where NAVD88 is near 0 ft.

1.1.2 Environmental Data Review

Existing geoenvironmental data, reports, and studies performed at or near Recycle Hill were reviewed and used in the preparation of this GTM. The data included groundwater level and quality data, landfill leachate and gas collection systems data, and soil boring data. Valley Water and the City of Sunnyvale provided several documents related to the site, including the primary documents used in the geoenvironmental investigation. These two documents are the City of Sunnyvale Landfill Postclosure Maintenance Plan (SCS 2012) and the Annual Self-Monitoring Report: Corrective Action Program, City of Sunnyvale Landfill (Ulrick 2018).

An Internet search for information related to Recycle Hill was conducted to determine offsite soil and groundwater conditions that could potentially have an impact on future site development. The State Water Resources Control Board's (Water Board) GeoTracker website is a data management system for sites that impact, or have the potential to impact, water quality in California, with emphasis on groundwater. GeoTracker contains records for sites that require cleanup, such as leaking underground storage tank (LUST) sites, U.S. Department of Defense sites, and cleanup program sites. GeoTracker records for the subject site pertained to monitoring of groundwater, leachate, and surface water for the Sunnyvale landfill that provided groundwater level data and water quality data (Sunnyvale Landfill Self-Monitoring Reports, Corrective Action Program, 2005 through 2017). No other subsurface information, such as boring logs, was available in the GeoTracker data.

The specific GeoTracker site name for the Sunnyvale Landfill is "Sunnyvale Solid Waste Disp (L10003423381)." GeoTracker data from several of the sites were used in this study and are further discussed in Section 2.2.4.

1.1.3 Regional Geologic Setting

The project site at Recycle Hill is located at the north end of broad alluvial fans that slope gently to the north from highland areas surrounding the southern Santa Clara Valley. The Holocene-age alluvial deposits, formed on a broad flat plain at the margin of San Francisco Bay, are distinctly fine-grained sand, silt, and clay and referred to as alluvial fan (Qhaf) and basin deposits (Qhb) (Figure 1-2, Brabb et al. 2000). The site is underlain by silty clay fan deposits that merge northward (and locally overlie) with estuarine organic clay and silty clay generally referred to as Bay Mud (Qhbm). The alluvial fan basin deposits in the project area contain carbonate nodules or concretions and iron staining indicative of the mixing of fresh water and sea water at the bay margin interface (Brabb et al. 2000). Basin deposits are very fine silty clay deposits that reached the distal edge of the alluvial fan.

The project site is bounded on the west by artificial levees (alf) that border Moffett Channel, which drains northward between salt ponds to reach Guadalupe Slough. Recycle Hill is a 40-foot-high mound representing one of four cells of the closed City of Sunnyvale MSW landfill. Nearby geotechnical borings encountered 9 to 14 feet of artificial fill overlying lean clay, lean clay with sand, and sandy lean clay. The clay deposits represent the Holocene distal alluvial fan deposits (SCI 1992; Fugro 2016). Soft Bay Mud (Qhbm) was not encountered in these borings located on the north side of Recycle Hill or in borings located 500 feet north within WPCP (Fugro 2016).

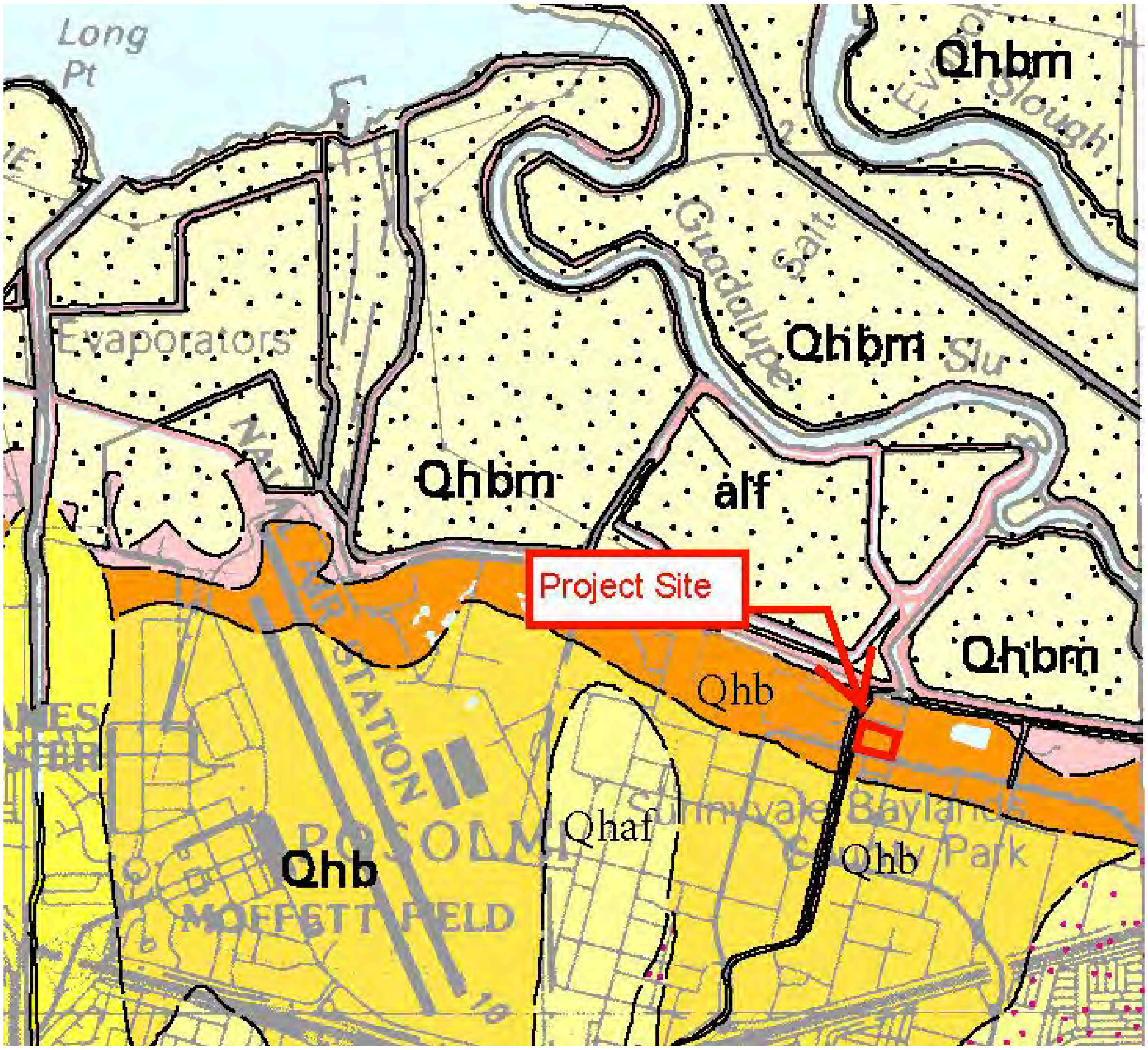


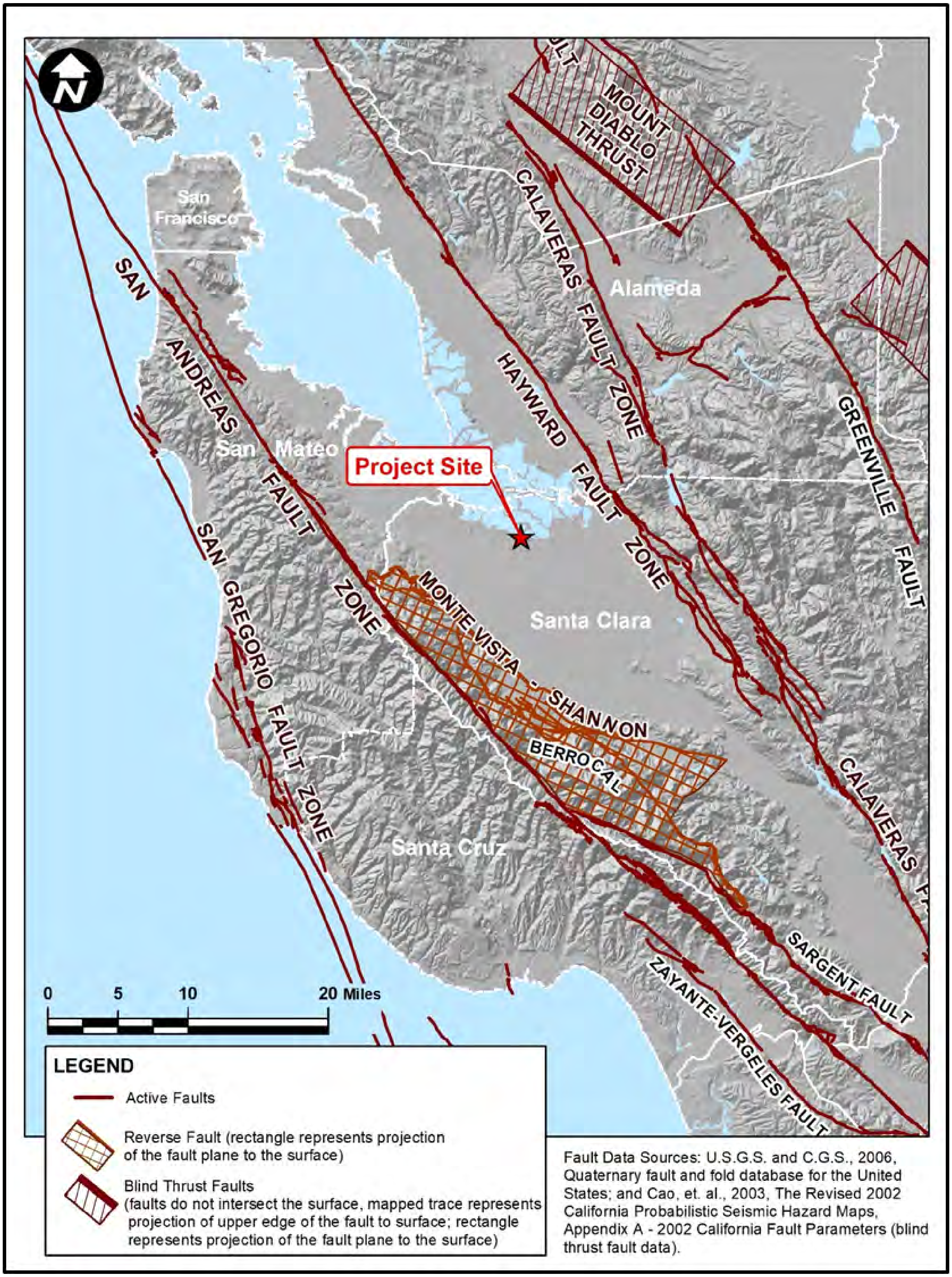
Figure 1-2. Regional geologic map

1.1.4 Regional Seismic Setting

Recycle Hill is in a seismically active region near the boundary between two major tectonic plates—the Pacific Plate to the southwest and the North American Plate to the northeast. The relative movement between the Pacific Plate and the North American Plate generally occurs across a 50-mile-wide zone extending from the San Gregorio Fault in the southwest to the Great Valley Thrust Belt in the northeast. Strain produced by the relative motions of these plates is relieved by right lateral strike slip faulting on the San Andreas Fault Zone and related faults (San Gregorio, Calaveras, and Hayward), and by vertical reverse slip displacement on the Great Valley and other thrust faults in the central California area.

Strong ground shaking at the project area could occur from an earthquake on any one of the active regional faults shown on Figure 1-3. The San Andreas Fault, the dominant tectonic feature of the San Francisco Peninsula, is the primary structure within the broad transform boundary that accommodates right lateral motion between the North American and Pacific tectonic plates. The United States Geological Survey (USGS) 2014 Working Group on California Earthquake Probabilities (2014 WGCEP) has concluded that there is a 72 percent probability of a strong earthquake (maximum moment magnitude [M_w] ≥ 6.7) occurring in the San Francisco Bay region over the next 30 years, starting in 2014 (2014 WGCEP 2015a). Additionally, the 2014 WGCEP (2014 WGCEP 2015b) has concluded that within the next 30 years (starting in 2014) the probability of a strong earthquake ($M_w \geq 6.7$) occurring on regional faults is:

- 33 percent for the North San Andreas Fault Zone
- 32 percent for the Hayward-Rodgers Creek Fault Zone
- 25 percent for the Calaveras Fault Zone



Fault Data Sources: U.S.G.S. and C.G.S., 2006, Quaternary fault and fold database for the United States; and Cao, et. al., 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps, Appendix A - 2002 California Fault Parameters (blind thrust fault data).

Figure 1-3. Regional fault map

Active faults in California have been divided into activity categories by the California Geological Survey (CGS) based on their predicted activity and ability to generate strong earthquakes:

- Type A faults, which generally have higher and more well-defined slip rates and well-defined recurrence intervals
- Type B faults, which generally have well-defined slip rates but poorly constrained recurrence intervals

Type A faults are commonly considered more active (generally with higher slip rates) and/or capable of generating larger earthquakes than Type B faults. USGS has divided the major active faults in the San Francisco Bay Area into segments based on work by the 2007 WGCEP (WGCEP 2008). Based on this segmentation, various fault rupture scenarios were developed that include earthquakes and rupture of segments of the individual faults in varying segment combinations, i.e., rupture of one segment by itself or rupture of two or more segments concurrently. These scenarios result in differing earthquake and fault parameters for each of the potential segment combinations.

Both Type A and Type B faults that are mapped in the region are summarized in Table 1-2. The nearest Type A faults to the project site are the Peninsula segment of the San Andreas Fault, passing about 10.5 miles to the southwest, and the Hayward Fault, located 7.2 miles to the east. The distance to significant active faults and fault segments from the approximate center point of the project area, CGS assigned fault type (A or B), estimated maximum magnitude earthquake, and 30-year probability of a $M_w \geq 6.7$ earthquake on the fault or fault segments, are summarized in Table 1-2.

Table 1-2. Significant Active and Potentially Active Faults

Fault Name	Distance to Faulta (miles)	Estimated Earthquake Magnitudeb	30-Year Probability of Mw >6.7 Earthquakec (percent)
Active Type A Faults			
North San Andreas segments: Offshore, North Coast, Peninsula, Santa Cruz Mountain	10.5	7.9	33
North San Andreas Segments: Peninsula, Santa Cruz	10.5	7.5	
North San Andreas Segment: Peninsula	10.5	7.2	
North San Andreas Segment: North Coast	16.7	7.1	
Hayward–Rodgers Creek: Rodgers Creek, North and South sections	7.2	7.3	32
Hayward–Rodgers Creek: North and South sections	8.7	7.0	
Hayward–Rodgers Creek: South Section	8.7	6.8	
Hayward–Rodgers Creek: North Section	30.2	6.6	
Calaveras: North	11.6	6.9	25
Calaveras: North, Central	11.6	7.0	
Calaveras: North, Central, South	11.6	7.0	

Table 1-2. Significant Active and Potentially Active Faults

Fault Name	Distance to Faulta (miles)	Estimated Earthquake Magnitudeb	30-Year Probability of Mw >6.7 Earthquakec (percent)
Potentially Active Type B Faults			
Monte Vista-Shannon	7.6	6.5	1
San Gregorio: Connected [d, e]	10.3	7.5	5
Mount Diablo Thrust	21.9	6.7	3
Green Valley Connected [e]	33.3	6.8	7

a. *Fault-to-site distances based on the 2008 updated National Seismic Hazard Mapping program (Petersen et al. 2008) and 2008 National Seismic Hazard Maps: Fault Parameters website (USGS 2018) at https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/.*

b. *Maximum earthquake magnitude: The maximum earthquake that appears capable of occurring under the presently known tectonic framework, magnitude listed is "Ellsworth-B" magnitude from USGS OF2007-1437 (Supporting Documentation for the Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2) (WGCEP 2008).*

c. *30-year probability of* $M_w \geq 6.7$ *earthquake based on 2014 WGCEP (2014 WGCEP 2015b).*

d. *San Gregorio Fault analyzed as a Type A fault by the 2007 WGCEP (WGCEP 2008).*

e. *The term "connected" means that the USGS (WGCEP) analyses of potential rupture and maximum magnitude for that fault is looking at a maximum event (rupture) anywhere along the entire length of the fault (i.e., segments all connected) as opposed to analyses of rupture and magnitude because of earthquake events as related to individual segments of the fault.*

1.1.5 Site Location and Past Use

The site of the Sunnyvale landfill was originally a flat, bayward-sloping plain with the surface elevation at or near mean sea level. In the 1920s, waste material, including municipal waste, construction debris, and non-hazardous industrial and commercial waste was placed directly onto the ground surface. The waste was formed into four hills: West Hill, Recycle Hill, South Hill, and East Hill. Waste was received at the landfill until September 1993, and the landfill was capped in 1994 in accordance with an approved Closure Plan submitted in 1990. The landfill cap consisted of a minimum 4-foot-thick cover (1- to 2-foot foundation layer, 1.0- to 1.5-foot low-permeability clay, and 1.0- to 1.5-foot vegetative topsoil). The topsoil was seeded with native grasses and irrigated (RWQCB 2004).

The landfill is currently in its post-closure monitoring and maintenance phase and is required to comply with many federal, state, and local regulations administered by the U.S. Environmental Protection Agency (EPA), California Air Resources Board, Regional Water Quality Control Board (RWQCB) San Francisco Region, CalRecycle, Bay Area Air Quality Management District (BAAQMD), and Santa Clara County Department of Environmental Health (RWQCB 2004).

1.1.6 Site Conditions

This section describes site conditions, including geotechnical conditions and the hydrogeologic setting.

1.1.6.1 Geotechnical Conditions

Recycle Hill is one of four units of the City of Sunnyvale Landfill and is bounded by the WPCP and associated access and parking area to the north; paved roadways on the east and south sides; and Moffett Channel on the west. Recycle Hill measures approximately 750 feet x 500 feet and 40 feet high. The landfill perimeter is at elevation +2 and rises to elevation +43 feet where a narrow top measures about 20 feet wide x 250 feet long. The landfill side slopes are inclined at about 22 to 25 percent (4:1 slope) and are generally uniform. A narrow dirt track road extends from the northwest corner to the top. The landfill mound is covered with low grasses and enclosed by chain-link fence.

At the Recycle Hill landfill artificial fill is used as cover soil and also underlies the adjacent roadways and parking areas at the WPCP. Geotechnical borings on the north side of Recycle Hill (and throughout the WPCP) indicate that the subsurface soils beneath the landfill consist of medium stiff to very stiff lean clay, sandy clay, and silty clay deposits to depths of 100 feet. One or two thin interbeds (approximately 5 feet thick) of medium-dense to dense silty sand, clayey sand, and poorly graded sand occur below a depth of 35 feet in most borings. Boring logs reviewed are inadequate to interpret the exact depth and thickness of these geologic units beneath Recycle Hill. Geotechnical borings were performed by Fugro Consultants, Inc. (Fugro 2016) and Subsurface Consultants, Inc. (SCI 1992) for the proposed administration building at the north side of the Recycle Hill site. No geotechnical information is available below the existing landfill. Our estimation of the geologic profile at the site based on the limited available data includes a blanket of artificial fill and probable refuse debris outside of the assumed landfill area to depths up to 15 feet below existing grade (SCI 1992; Fugro 2016), overlying predominantly stiff clay deposits to the maximum depth explored of 100 feet.

Artificial Fill (af). The closed landfill mound has a minimum of 4 feet of artificial fill cover (RWQCB 2004). The flat areas surrounding the landfill are underlain by fill to support the local roadways and parking areas in the developed areas. Fill encountered in borings on the north side of Recycle Hill consists of clayey gravel, silty lean clay, and fat clay measuring 4 to 9 feet thick that in turn overlies landfill waste extending to depths of 9 to 15 feet nearest to the north landfill mound (SCI 1992; Fugro 2016).

Bay Mud (Qbm). Holocene-age Bay Mud is mapped north of the site beneath the salt ponds and wastewater oxidation ponds (Figure 1-2; Brabb et al. 2000). The Bay Mud interfingers with and grades into the fine-grained deposits at the distal edges of the Holocene alluvial fans that border southern San Francisco Bay (Brabb et al. 2000). Soft, saturated estuarine mud comprising lean clay, fat clay, and silty clay was not encountered in borings drilled near Recycle Hill, suggesting that Bay Mud deposits do not underlie the project site.

Basin Deposits (Qhb). Basin deposits encountered in the nearby deep geotechnical borings predominantly comprise clay with thin interbeds of fine-grained sand. Lean clay, sandy lean clay, and rare fat clay are generally stiff to very stiff, and locally hard, to the maximum depth of investigation (101 feet) (SCI 1992; Fugro 2014). The thin interbeds of granular soils comprise medium-dense to dense sandy clay, silty sand, poorly graded sand with silt, and minor well-graded sand with gravel. The thickness of the alluvial fan deposits (Qhaf, Qhb) is greater than the exploration depth (100 feet).

1.1.6.2 Hydrogeologic Setting

The site overlies the very northern portion of the Santa Clara subbasin of the Santa Clara Valley Groundwater Basin, Basin 2-9.02 (DWR 2003). The Santa Clara subbasin is within a structural trough parallel to the northwest trending Coast Ranges. The Diablo Range and Santa Cruz Mountains form the basin boundary on the west and east, respectively. The basin extends from the northern border of Santa Clara County to the groundwater divide near the town of Morgan Hill, approximately 25 miles. The valley is drained to the north by tributaries to San Francisco Bay including Coyote Creek, the Guadalupe River, and Los Gatos Creek. Annual precipitation for the Santa Clara basin ranges from less than 16 inches in the valley to more than 28 inches in the upland areas. The water-bearing formations of the Santa Clara subbasin include Pliocene- to Holocene-age continental deposits of unconsolidated to semi-consolidated gravel, sand, silt, and clay. Two members form this group—the Santa Clara Formation of Plio-Pleistocene age and the younger alluvium of Pleistocene to Holocene age (DWR 2003). The younger alluvium is the primary shallow water-bearing deposits of interest in this study. The younger alluvium extends from the ground surface to a depth of approximately 1,000 feet beneath the site. The younger alluvium interfingers with the fine-grained marine clays deposited during the periodic incursions of the San Francisco Bay (McLaren 1987). Figure 1-3 provides a generalized schematic of the aquifer system underlying the site.

Alternating fine- and coarse-grained deposits underlie the site. The coarse-grained water-bearing deposits have been divided into an Upper Aquifer Zone and a Lower (or Deeper, as shown on Figure 1-4) Aquifer Zone based on the conditions of groundwater occurrence. Groundwater-bearing deposits within 100 feet of the ground surface compose the Upper Aquifer Zone and can be confined, semi-confined, and unconfined (McLaren 1987).

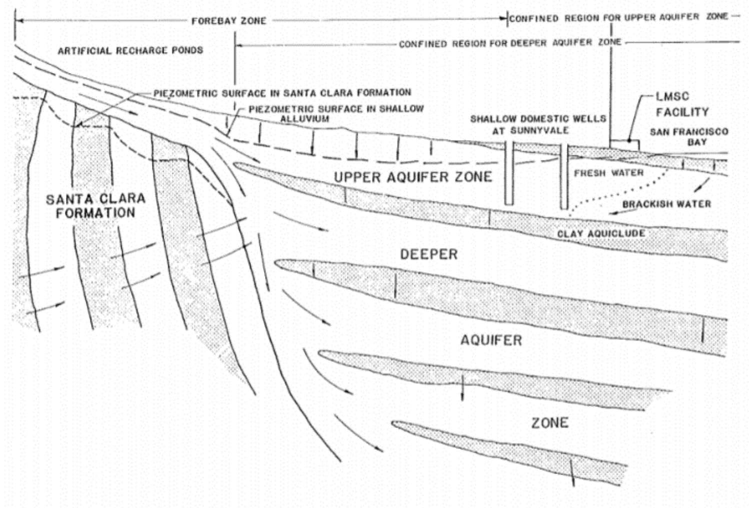

FOREBAY ZONE
CONFINED REGION FOR UPPER AQUIFER ZONE
CONFINED REGION FOR DEEPER AQUIFER ZONE
ARTIFICIAL RECHARGE PONDS
PIEZOMETRIC SURFACE IN SANTA CLARA FORMATION
PIEZOMETRIC SURFACE IN SHALLOW ALLUVIUM
SHALLOW DOMESTIC WELLS AT SUNNYVALE
LMSC FACILITY
SAN FRANCISCO BAY
UPPER AQUIFER ZONE
FRESH WATER
BRACKISH WATER
SANTA CLARA FORMATION
CLAY AQUICLUDE
DEEPER
AQUIFER
ZONE

Figure 1-4. Aquifer conceptual model

Source: McLaren 1987.

Section 2: Site Conditions

This section presents a discussion of the site-specific geotechnical conditions, geologic hazards, and geoenvironmental conditions at the proposed recycled water treatment plant site. This discussion is based on available published geologic reports and geotechnical boring logs for the immediately adjacent administration building (proposed) site and the Sunnyvale WPCP.

2.1 Geotechnical Conditions

Site-specific geotechnical conditions and geohazards are estimated from various sources and presented below. A thorough geotechnical investigation, laboratory testing, and engineering analysis will be required to address these issues and develop recommendations for the design of new facilities.

2.1.1 Strong Ground Shaking

The Recycle Hill site is relatively close to multiple faults as shown on Figure 1-3 and presented in Table 1-2. The closest faults to the site are the Hayward Fault, Monte Vista-Shannon Fault, and San Andreas Fault, which are considered capable of generating earthquakes of M_W 7.3, 6.5, and 7.9, respectively. Strong ground shaking at the site will result from a large earthquake on any of the regional faults presented in Table 1-2.

2.1.2 Fault Rupture

No active or potentially active faults are known to cross the site. Consequently, the hazard posed by ground rupture due to fault offset is considered very low.

2.1.3 Groundwater Depth

Groundwater levels at the northern end of the Recycle Hill site observed during geotechnical drilling (1992 and 2014) vary between approximately 10 and 15 feet below existing grade. Given the proximity of the site to the San Francisco Bay, it is likely that groundwater levels fluctuate with the tides, but with damped magnitude and time delay. Depending on the scope of the proposed improvements, this tidal-groundwater relationship should be evaluated during the design-level geotechnical investigation. Table 2-1 below summarizes the observed groundwater conditions from the SCI and Fugro investigations.

Table 2-1. Summary of Groundwater Readings

Boring	Date of Groundwater Reading	Approximate Ground Surface Elevation (ft)	Approximate Depth to Groundwater[a] (ft)	Approximate Groundwater Elevation (ft)[b]
SCI, TB-6	7/14/1992	3.3[c]	12	-8.7
SCI, TB-7	7/17/1992	3.3[c]	14	-10.7
SCI, TB-8	7/14/1992	3.7[c]	12	-8.3
SCI, TB-10	7/14/1992	3.8[c]	14	-10.2
Fugro, B-12	10/2/2014	107.0 +/-[d]	12.5	-5.5
Fugro, B-13	10/3/2014	107.0 +/-[d]	13.0	-6
Fugro, B-14	Not observed	106.0 +/-[d]	Not observed	NA

a. *Depths given as measured from existing ground surface at time of drilling.*

b. *Approximate groundwater elevation normalized to NAVD88.*

c. *The exact elevation datum used on the SCI boring logs is unknown.*

d. *Datum noted on Fugro boring logs is assumed to be NAVD88 +100 feet, as is common practice at locations where NAVD88 is near 0 ft.*

Groundwater levels are expected to rise commensurate with 2 to 8 feet of sea level rise projections for the San Francisco Bay Area (BCDC 2017) at the site within a 50-year design life. A detailed estimate and discussion of groundwater elevation with respect to sea level rise should be included during future geotechnical analysis of the site addressing specific facilities.

2.1.4 Liquefaction

Liquefaction is a phenomenon wherein a temporary reduction of soil shear strength occurs because of increases in pore pressure that result from cyclic loading of soils during earthquakes. In general, saturated, loose to medium-dense sands and silty sands that are within about 50 feet of the ground surface are most susceptible to liquefaction. Consequences of liquefaction can include:

- Partial to total loss of support for foundations underlain by the liquefied soils
- Sudden and dramatic settlement indicative of bearing failure, with a large differential subsidence and tilting of structures supported above the liquefied layer
- Surface settlements due to volumetric compression of the liquefied layer or due to loss of liquefied material as a result of sand boils or lateral-spreading accompanying liquefaction
- Downdrag forces developed along the sides of deep foundations and below-grade structures due to the settlement of the liquefied layer and any other soil strata present above the liquefied layer
- Lateral spreading of the ground surface where liquefaction occurs on or near slopes causing significant lateral forces on below-grade structures or utilities

The site is located in areas mapped by USGS (Knudsen et al. 2000) and CGS (CGS 2006) as having high susceptibility to liquefaction; however, the USGS/CGS interpretation is not site-specific. The reviewed data do not indicate the presence of sandy soils that are prone to liquefaction. Preliminarily, based on the limited available data reviewed, the site does not appear to be highly susceptible to liquefaction; however, further investigation is required to perform a detailed site-specific liquefaction assessment.

2.1.5 Lateral Spread

Lateral spreading is a liquefaction-induced lateral ground deformation failure in which near-surface soils move down-slope or toward a nearby free face such as a stream channel, embankment, or shoreline. Because of the anticipated lack of a continuous layer of liquefiable soils, the level topography of the site, and the levee confining the site along the east side of the Moffett Channel, our preliminary assessment is that the potential for lateral spreading toward the channel is considered low. Further investigation including an assessment of the levee design and construction is required to confirm this preliminary assessment.

2.1.6 Dynamic Settlement (Densification)

In addition to settlements caused by post-liquefaction volumetric reconsolidation of saturated soils (liquefaction), dynamic settlements due to volumetric contraction (densification) of non-saturated soils (above the water table) may also occur during strong ground shaking. The limited available data reviewed do not indicate a significant potential for dynamic settlement assuming that existing landfill material is mitigated in some manner; however, further investigation is required to confirm this preliminary assessment.

2.1.7 Consolidation Settlement

Consolidation settlements may occur in softer clayey geologic layers with additional fill or structural loads. The magnitude of settlement will depend on the physical extent and geotechnical properties of susceptible layers and may occur over several decades. Reviewed data indicate relatively stiff clays below the existing landfill, showing low potential for significant consolidation settlements; however, further investigation is required to confirm this preliminary assessment.

2.1.8 Landslides/Slope Instability

Assuming that the landfill is removed prior to construction, the relatively flat terrain of the Recycle Hill site is not subject to hazards associated with slope instability or seismically induced landslides.

2.1.9 Tsunami

Tsunami inundation modeling results (CGS 2009) indicate that wave run-up would occur along several of the nearby channels, including Guadalupe Slough. The tsunami models are based on very large earthquake scenarios on nearby sources such as Point Reyes Thrust Fault and Rodgers Creek-Hayward faults, and distant sources, including the Cascadia, Aleutians, and Japan subduction zones. Based on this modeling, the predicted wave run-up extends about 0.7-miles up Guadalupe Slough and does not reach the mouth of Moffett Channel (CGS 2009). Tsunami wave height and predicted run-up should be verified during the geotechnical investigation.

2.1.10 Sea Level Rise

Sea level rise from global climate change is a significant concern for structures built near tidal bodies of water and is additive to other forms of water level rise, such as storm surge, storm waves, tsunami, or El Niño effects. The Recycle Hill site is in the immediate vicinity of tidally influenced channels. Sea level rise inundation maps for Santa Clara County identified that most of the salt pond berms are constructed to elevations higher than mean higher high water (MHHW, extreme tide scenario) +24 inches (BCDC 2017) and generally protect the nearby low-lying areas. However, the MHHW +36-inch scenario results in the salt pond and other levees being overtopped and inundation of the WPCP and commercial areas south of Caribbean Drive. Higher sea level rise scenarios would further impact the project site. Future grading of the site and adjacent levees should consider sea level rise. In addition, sea level rise will likely raise the groundwater level at the site comparable to sea level rise projections of 12 to 36 inches considered reasonable for the San Francisco Bay Area by 2100, although projections near 66 inches are possible (BCDC 2017). Sea level rise effects should be reviewed with current projections during the geotechnical investigation to support planning for the proposed project grade and groundwater levels.

2.1.11 Corrosion

Corrosive soils and corrosive saline groundwater can cause damage to structures, foundations, and buried utilities and can also increase required maintenance. Depending on the degree of corrosivity of subsurface soils, concrete, reinforcing steel in concrete structures, and bare metal structures exposed to these soils can deteriorate, eventually leading to structural failure. Typically, at a site this close to the Bay, uncoated steel may be susceptible to corrosion. Corrosion mitigation measures may be required for any ferrous materials exposed to the surrounding soils (e.g., steel beams, rebar, driven steel H-piles, etc.).

The actual corrosion potential of soils underlying the Recycle Hill site should be evaluated during the final geotechnical investigation.

2.2 Geoenvironmental Conditions

This section summarizes the soil and groundwater conditions (collectively referred to herein as the geoenvironmental conditions) of Recycle Hill and its surrounding areas as they relate to hazardous materials released to the subsurface resulting from historic landfill operations. The summary is focused primarily on groundwater conditions, as there are little data related to the very thin to nonexistent unsaturated zone between the landfill refuse and the groundwater.

The City of Sunnyvale is the owner and operator of record for the Sunnyvale Landfill and currently monitors the landfill under the Sunnyvale Landfill Postclosure Maintenance Plan (SCS 2012). The plan was prepared in accordance with Title 27 of the California Code of Regulations (27 CCR). The monitoring system consists of groundwater monitoring wells used to collected level and water quality data, surface water monitoring points used to measure surface flows and water quality, a leachate monitoring and collection system used to collect landfill leachate and monitor leachate levels, and a landfill gas collection system used to collect landfill gas generated during waste decomposition. Figure 2-1 shows the various Sunnyvale Landfill monitoring station locations, with Recycle Hill outlined with an orange dashed line. San Francisco RWQCB Order R2-2004-0030, adopted May 19, 2004, implements a Corrective Action Program Self-Monitoring Report (CAP SMR) for the Sunnyvale Landfill. The CAP SMR is prepared annually for the landfill to document compliance with the post-closure plan and current site conditions. The principal objectives of the CAP SMRs are to:

- Verify the continued hydraulic capture of groundwater beneath the landfill, as defined in the CAP
- Report the results of field monitoring and laboratory analyses of the physical and chemical characteristics of the groundwater, surface water, and leachate at the landfill

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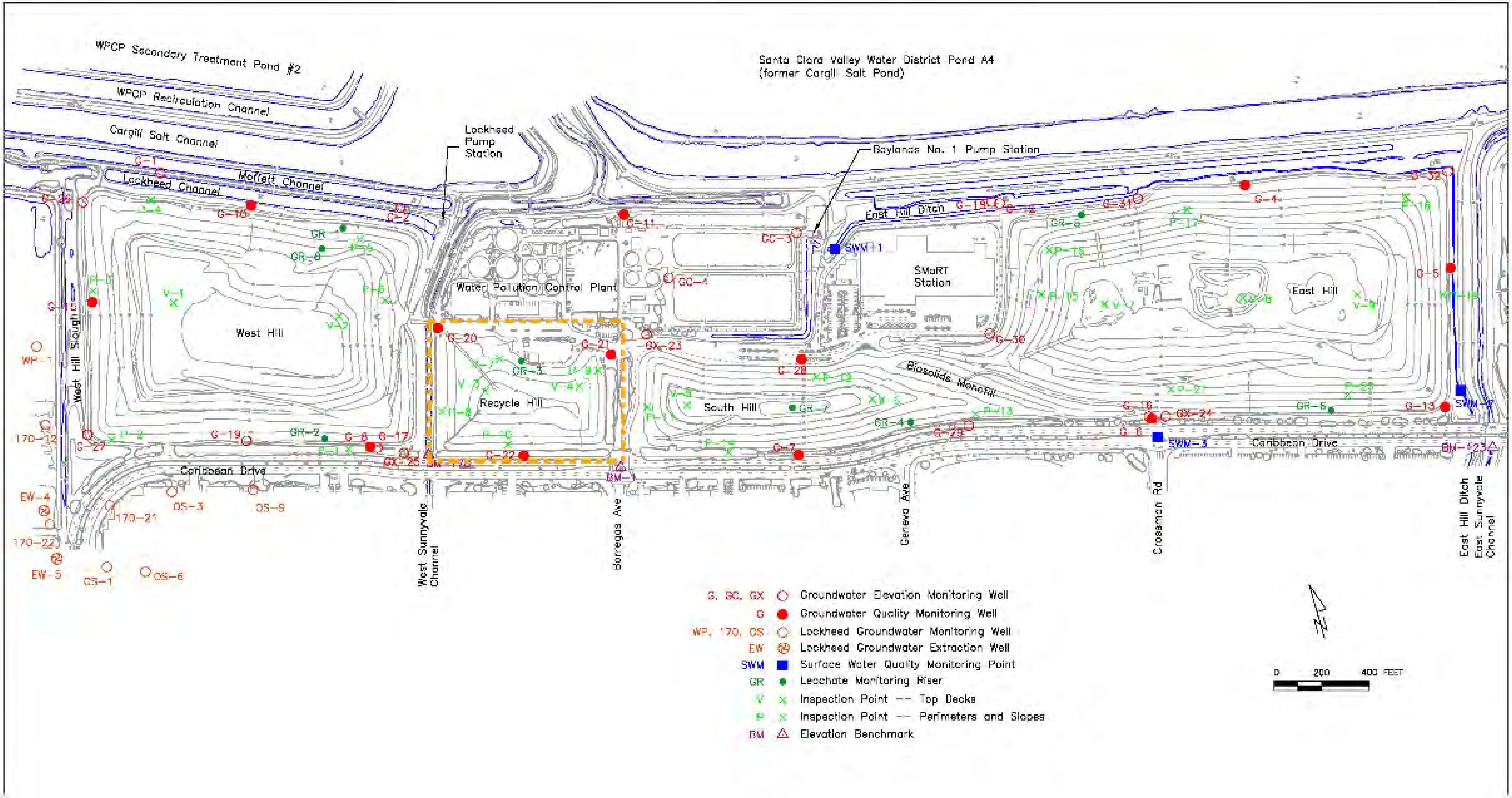
WPCP Secondary Treatment Pond #2
WPCP Recirculation Channel
Cargill Salt Channel
Lockheed Channel
Moffett Channel
Lockheed Pump Station
Santa Clara Valley Water District Pond A4
(former Cargill Salt Pond)
Baylands No. 1 Pump Station
East Hill Ditch
SMaRT Station
Water Pollution Control Plant
West Hill
Recycle Hill
South Hill
East Hill
Biosolids Monofill
West Hill Slough
Caribbean Drive
West Sunnyvale Channel
Borregas Ave
Geneva Ave
Crossman Rd
East Hill Ditch
East Sunnyvale Channel
SWM-1
SWM-2
SWM-3
BM-1
BM-123
G, GC, GX ○ Groundwater Elevation Monitoring Well
G ● Groundwater Quality Monitoring Well
WP, 170, OS ○ Lockheed Groundwater Monitoring Well
EW Lockheed Groundwater Extraction Well
SWM ■ Surface Water Quality Monitoring Point
GR ● Leachate Monitoring Riser
V × Inspection Point — Top Decks
P × Inspection Point — Perimeters and Slopes
BM △ Elevation Benchmark
0 200 400 FEET

Figure 2-1. Sunnyvale Landfill monitoring points

Source: Ulrick & Associates 2018.

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2.2.1 Onsite Groundwater Conditions

There are 31 groundwater monitoring wells at the landfill that are used to measure groundwater levels on a semi-annual basis (Ulrick 2018), as shown on Figure 2-1. Thirteen of the 31 wells are included in the water quality monitoring program that is performed on an annual basis (G-4, G-5, G-6, G-7, G-8, G-10, G-11, G-13, G-15, G-20, G-21, G-22, and G-28). The 13 water quality wells are monitored for:

- **Field parameters:** turbidity, electrical conductivity, pH
- **Inorganic parameters:** chloride, chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammonia, ammonia-nitrogen, total Kjeldahl nitrogen, nitrate + nitrile nitrogen, and total nitrogen
- **Organic parameters:** total phenols, fuel additives (benzene, toluene, ethylbenzene, and xylene [BTEX] and methyl tert-butyl ether [MTBE]), and volatile organic compounds (VOC)

Wells G-20, G-21, and G-22 are along the perimeter of Recycle Hill, and the water level and water quality data from these wells best represent groundwater conditions beneath Recycle Hill. The depth to water and groundwater elevations measured at Recycle Hill during the March 2018 monitoring event (Ulrick 2018) are summarized in Table 2-2 and depicted on Figure 2-2. Groundwater elevations increase during the rainy season because of rainfall recharge and decrease during the dry season due to groundwater discharge to sinks (underlying sewers and storm drains) and to evapotranspiration. Leachate and groundwater elevations indicate either a similar response to rainfall recharge and discharge or some degree of hydraulic communication between leachate and groundwater (Ulrick 2018). Historically, groundwater elevations have remained fairly constant at the Recycle Hill monitoring wells (Ulrick 2018).

Table 2-2. Groundwater Levels at Recycle Hill

Well Number	Date Measured	Datum Elevation (ft NAVD)	Depth to Water (ft)	Groundwater Elevation (ft NAVD)
G-20	3/12/2018	8.99	14.35	-5.36
G-21	3/12/2018	8.97	15.85	-6.88
G-22	3/12/2018	3.65	7.40	-3.75

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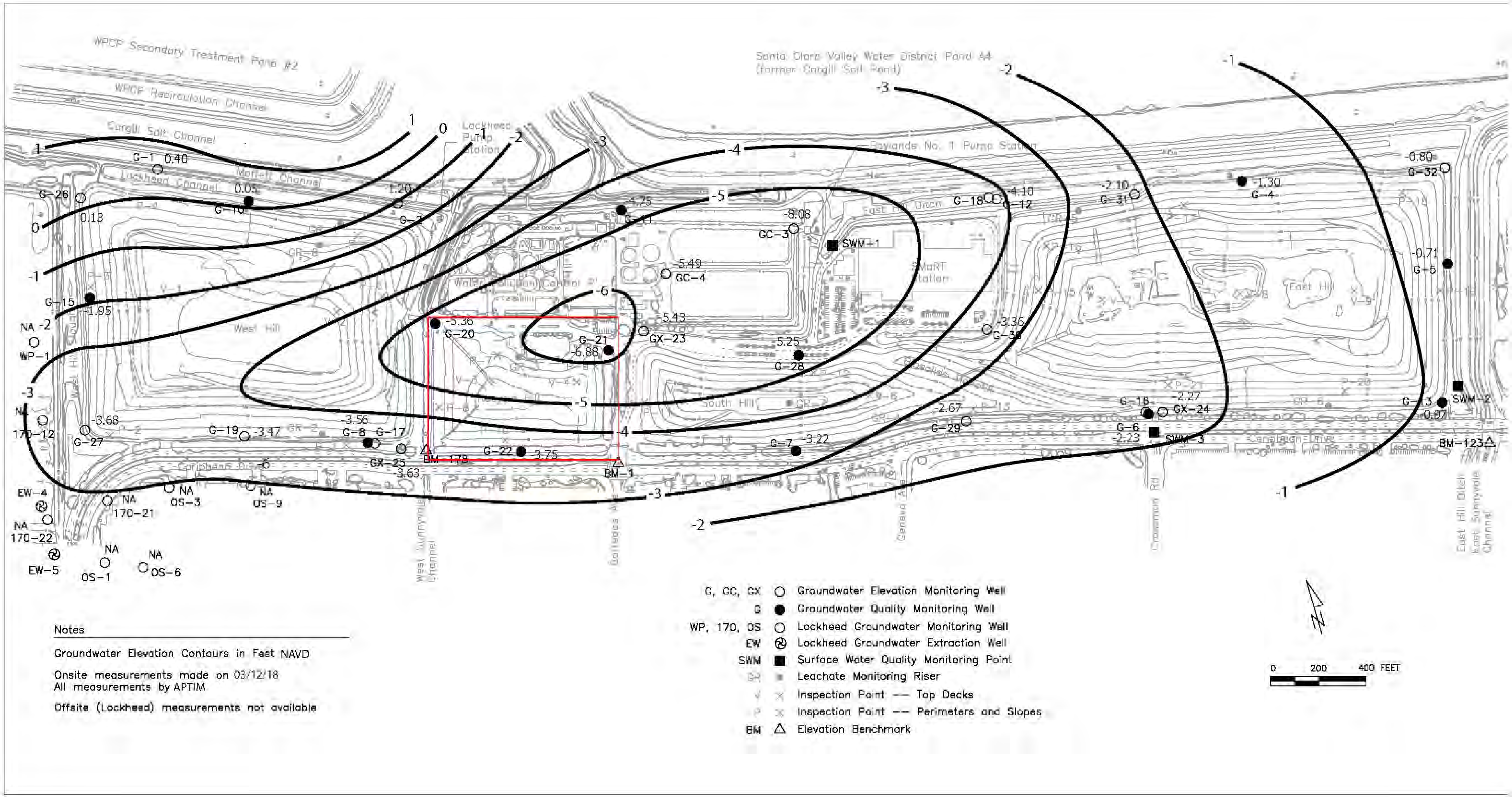

Notes

Groundwater Elevation Contours in Feet NAVD

Onsite measurements made on 03/12/18
All measurements by APTIM

Offsite (Lockheed) measurements not available

G, GC, GX	○	Groundwater Elevation Monitoring Well
G	●	Groundwater Quality Monitoring Well
WP, 170, OS	○	Lockheed Groundwater Monitoring Well
EW	⊗	Lockheed Groundwater Extraction Well
SWM	■	Surface Water Quality Monitoring Point
GR	▪	Leachate Monitoring Riser
V	×	Inspection Point — Top Decks
P	×	Inspection Point — Perimeters and Slopes
BM	△	Elevation Benchmark

Figure 2-2. March 2018 groundwater elevation contours

Source: Ulrick & Associates 2018.

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The primary water quality concerns related to the development of Recycle Hill for a water treatment plant are those chemicals and constituents that can result in exposure levels to human and environmental receptors exceeding regulatory exposure limits during either site construction or operation. It is assumed that constituents currently in groundwater can be accepted into the WPCP, as they currently infiltrate into the underlying sewer system connected to the WPCP, as discussed below. Additionally, the shallow groundwater beneath the site will not be used as a potable water supply, so the exposure to inorganic parameters during site construction or operation pose little threat to human health or the environment. The organic parameters identified above are the focus of this evaluation, as they must be fully assessed to make informed management decisions related to the development of the site.

As discussed above, water quality data are collected from 13 wells on an annual basis. Water quality data for wells G-20, G-21, and G-22 (Recycle Hill wells) are discussed below and summarized in Table 2-3. Note only those organic parameters detected at one or more times above the method detection limit are shown in the table. All other organic parameters have historically been below detection limits.

Table 2-3. Groundwater Quality at Recycle Hill

Well	Constituent	PEL[b]	MCL[a]	Result by Year[a]												
				2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
G-20	1,1-DCA	100	5	0.8	2.4	ND	3.5	2.5	1.1	ND	ND	ND	ND	ND	ND	ND
	cis-1,2-DCE	200	6	ND	0.7	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Vinyl chloride	1	0.5	ND	1.6	ND	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND
G-21	Chlorobenzene	10	NA	1.3	1.1	0.6	ND	1.3	1.0	ND	1.1	1.4	1.8	2.0	2.0	2.0
	Chloroethane	100	NA	ND	ND	1.5	ND	ND	ND	ND	ND	ND	8.3	ND	3.9	ND
	1,4-dichlorobenzene	10	5	0.8	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.9	0.8
	1,1-DCA	100	5	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND
	Vinyl chloride	1	0.5	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
G-22	1,1-DCA	100	5	1.5	1.0	1.2	1.4	1.1	ND	ND	ND	ND	ND	ND	0.9	0.7
	1,1-DCE	1	6	17.0	9.8	17.0	18.6	17.6	8.5	13.8	13.5	13.0	14.2	12.7	13.0	11.0
	PCE	25	5	0.5	0.6	ND	ND	1.3	ND	1.0	1.4	1.2	1.5	1.5	1.6	1.4
	1,1,1-trichloroethane	350	200	1.2	1.4	1.0	1.1	1.2	ND	ND	ND	ND	ND	ND	ND	ND
	TCE	25	5	29.0	2.5	3.8	3.3	3.7	2.6	2.9	3.0	2.8	3.2	3.1	3.4	3.0

Notes:

a. All concentrations are in parts per million

b. All concentrations are in micrograms per liter

PEL: permissible exposure limit to airborne contaminant (expressed as an 8-hour total weight average concentration), Cal OSHA

ND: not detected at or above the method detection limit

MCL: maximum contaminant level for drinking water in California, March 2018

Well G-22 has consistently shown the highest VOC concentrations with trichloroethene (TCE) up to 29 micrograms per liter (µg/L) in 2006, and 1,1-dichloroethene (1,1-DCE) up to 18.6 µg/L in 2009; however, the 2018 monitoring event indicated much lower concentrations of these constituents, with only 3 µg/L TCE and 11 µg/L 1,1-DCE.

2.2.2 Onsite Surface Water Conditions

Three surface water monitoring points, SWM-1, SWM-2, and SWM-3, are used to monitor surface water flows within the East Hill portion of the landfill, as shown on Figure 2-1. Surface water enters the landfill at locations SWM-2 and SWM-3; downstream surface water monitoring point SWM-1 is located near the Baylands Pump Station forebay. Samples are collected from each point on an annual basis (when liquid is present) and analyzed for the parameters listed in Table 2-3 for groundwater. VOCs have not been detected at the surface water monitoring points since 2007.

2.2.3 Onsite Leachate Conditions

A Leachate and Groundwater Management Plan (LGMP) was established at the Sunnyvale Landfill in the early 1990s. The LGMP was undertaken in response to an RWQCB directive to provide an engineered alternative to the 5-foot separation requirement between MSW materials and the highest anticipated groundwater level (RWQCB Order 89-105). The LGMP system consisted of both leachate and groundwater extraction points, and was designed to remove accumulated leachate from the refuse mass, collect groundwater potentially contaminated with landfill leachate, and reduce groundwater elevations below the refuse prism.

The leachate and groundwater extraction points installed for the LGMP remain in place; however, these extraction points are used primarily for liquid-level monitoring and are no longer needed as a primary means for hydraulic control. Hydraulic capture is achieved by groundwater flow toward underground sinks (sanitary sewer and storm drain pipelines that underlie the landfill waste mass (RWQCB 2004, Ulrick 2018). Eight leachate risers extend into rock-lined leachate sumps installed on landfill slopes or on the top decks of the landfill, and completed below waste fill elevations. The leachate risers are designated GR-l through GR-8, with GR-3 monitoring leachate within Recycle Hill, and are shown on Figure 2-1. Leachate levels are monitored on a semiannual basis; leachate quality is monitored annually in accordance with RWQCB Order R2-2004-0030. The same suite of analytical parameters for groundwater are used to analyze leachate.

Leachate quality data for riser GR-3 (Recycle Hill riser) is discussed below and summarized in Table 2-4. Only those organic parameters detected at one or more times above the method detection limit are shown in the table. All other organic parameters have historically been below detection limits.

Table 2-4. Leachate Quality at Recycle Hill

Well	Constituent	MCL	Result by Year												
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GR-3	Chlorobenzene	NA	1	1.2	0.8	1.5	2.4	1.2	2	1.5	2.2	ND	ND	1.2	1.6
	Chloroethane	NA	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1,4-dichlorobenzene	5	1.3	1.2	0.8	1	ND	ND	1.2	ND	1.4	ND	ND	0.8	1
	1,1-DCE	6	ND	ND	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND: not detected at or above the method detection limit.
MCL: maximum contaminant level for drinking water in California, March 2018.

Leachate riser GR-3 has historically had detections of chlorobenzene and 1,4-dichlorobenzene below 3 µg/L. The 2018 monitoring event shows detections of chlorobenzene and 1,4-dichlorobenzene at concentrations of less than 2 µg/L. The California public health goals for chlorobenzene and 1,4-dichlorobenzene are 70 and 6 µg/L, respectively.

2.2.4 Offsite Groundwater Concerns

To determine the groundwater conditions offsite of the Sunnyvale Landfill, the State's GeoTracker website was used. Several sites listed on GeoTracker indicate past and current groundwater contamination. Figure 2-3 shows several sites around Recycle Hill that are in the GeoTracker database. There is also evidence of possible upgradient sources of organic compounds in the groundwater because four of the nine reported groundwater organic compounds detected in the 2018 CAP SMR (Ulrick 2018) for the Sunnyvale Landfill were reported in groundwater only and not in leachate. Four organic compounds are indicators of offsite groundwater contamination because they were detected in groundwater, but not in leachate, including:

- 1,1-dichloroethane (1,1-DCA)
- 1,1-dichloroethene (1,1-DCE)
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)

These compounds are known contaminants in the groundwater at the former 141 Caspian Court remediation site (AC BALL MENLO CASPIAN [T0608591628]), located about 400 feet south of the landfill near Borregas Avenue (Figure 2-3). Site cleanup at the 141 Caspian Court site was closed in February 2004.

TCE is a known contaminant in the groundwater at the Lockheed Sunnyvale Plant One Facility (SI1821f605), 1111 Lockheed Martin Way, located south and southwest of the southwest corner of the landfill (Figure 2-3). Contaminants known to exist at the Lockheed site include 1,1,1-trichloroethane, benzene, chromium, gasoline, nitrate, PCE, toluene, TCE, and xylene. A groundwater extraction and treatment system has been in full operation since 1993.

The groundwater flow direction at the Lockheed site is to the northeast toward the landfill (Cameron-Cole 2018). The TCE plume in the shallowest parts of the aquifer (locally known as the First and Second Transmissive Zones) appears to extend beyond the Lockheed site boundary but does not reach beneath Recycle Hill.

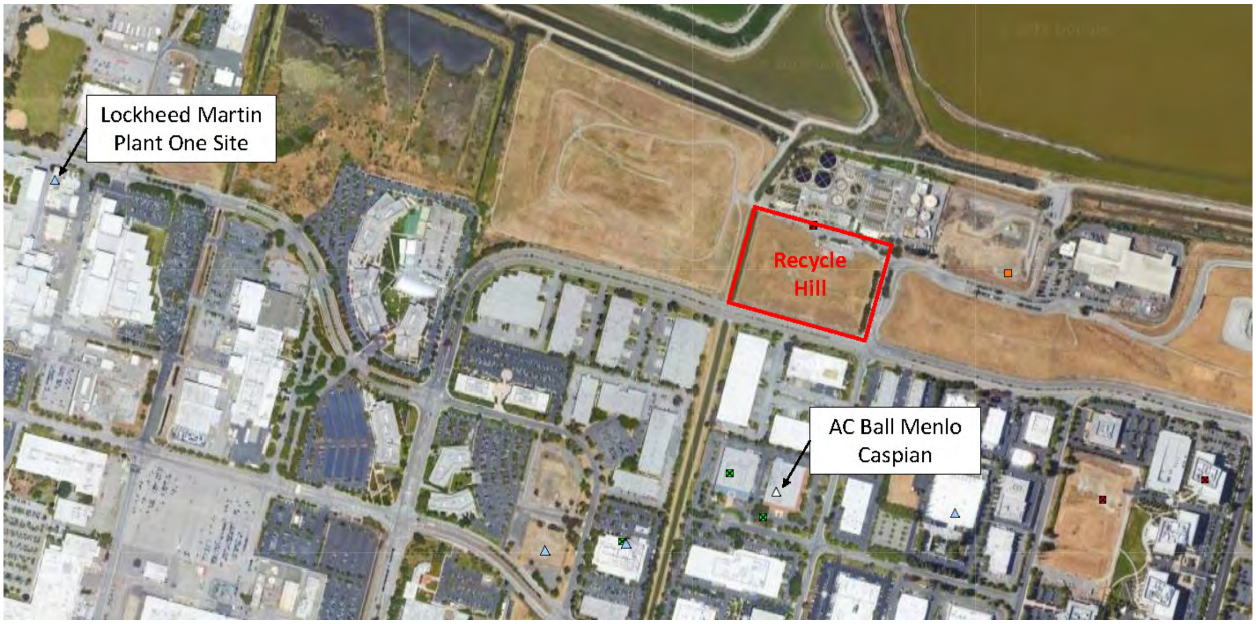

Figure 2-3. GeoTracker search of Sunnyvale Landfill

Section 3: Site Inspection Observations

The landfill mound at Recycle Hill rises approximately 40 feet above the surrounding grade at the margins of the San Francisco Bay where numerous channels feed the southern portion of the bay. Aside from the three other landfill hills adjacent to the site, the area is relatively flat terrain, built out over alluvial fan deposits covered by artificial fill. Background documents noted superficial slope erosion problems on the landfill slopes. These conditions were confirmed during our site reconnaissance; however, no large-scale failures were noted during our site visit.

Section 4: Data Gaps

This section describes geotechnical and geoenvironmental data gaps in the study.

4.1 Geotechnical

The available geotechnical data reviewed were limited to the north side of the Recycle Hill site, at the location of the proposed administration building. Previous studies for this area included seven geotechnical borings as performed by Fugro Consultants, Inc. (Fugro 2014) and Subsurface Consultants, Inc. (SCI 1992). The remainder of the site lacks sufficient geotechnical information that would be required for any large-scale development of the site.

4.2 Geoenvironmental

Geoenvironmental data gaps include current soil and groundwater conditions directly beneath Recycle Hill. Although three shallow groundwater wells along the perimeter of Recycle Hill are monitored annually, soil and groundwater conditions within the main waste area are unknown and could pose exposure to onsite workers during construction and could impact other construction-related concerns, such as waste handling and disposal. These data gaps can be filled during the detailed geotechnical investigation by collecting soil and groundwater samples from the geotechnical borings and analyzing those samples for VOCs and other chemicals of concern.

Section 5: Recommendations for Further Study

This section presents geotechnical and geoenvironmental recommendations for further study.

5.1 Geotechnical

Further geotechnical study consisting of a detailed geotechnical investigation with deep borings is required for any use of the Recycle Hill site related to the design and construction of a reclaimed water facility. It is likely that the existing landfill would be removed as part of the development effort and, as such, the geotechnical investigation should be performed after removal of the landfill to reduce difficulties associated with drilling through an existing landfill site. Geotechnical investigation of the site with the landfill in place will require piercing the landfill cover soils with borings and cone penetration tests (CPT), creating a potential path for landfill leachate or gases to escape the site and/or downward migration of leachate to the water table. If the existing landfill material is not removed prior to site work, the recommendations in this GTM and attached Geotechnical Exploration Plan (GEP) would need to be modified accordingly.

Difficulties associated with drilling through the landfill waste include but are not limited to (1) additional permitting for drilling through an existing closed landfill, (2) additional safety concerns associated with active drilling on a landfill that may produce toxic and explosive gases during the drilling process, (3) access for drilling equipment on landfill slopes, and (4) mitigation measures and repairs to the landfill facilities after geotechnical investigation.

The specific scope of the geotechnical investigation should be determined after a basic development scheme and layout is developed for the recycled water facility, and a site-specific GEP is developed after recycled water facilities options have been evaluated. Generally, the exploration plan may include:

- Drilling and sampling of six to eight geotechnical borings to collect disturbed and undisturbed samples, and completion of four to six CPTs to depths of 150 to 200 feet.
- A comprehensive laboratory test program to evaluate the engineering properties of the soils, including corrosion potential.
- Preliminary exploration at the four corners of the site may be performed prior to landfill removal. Each exploration point should include a minimum of one geotechnical boring to approximately 150 feet in depth. These borings may be used to broadly characterize the site and aid in preliminary design of site facilities while landfill removal is in progress. The preliminary geotechnical work should include recommendations for placement of compacted fill within the area of landfill removal.
- After landfill removal and preliminary design of site facilities, a detailed geotechnical exploration program may be developed for the site to provide information specific to the facilities. This exploration would likely consist of up to four additional deep borings and four to six CPTs.

The exploration plan and geotechnical investigation should be developed to address liquefaction, shallow groundwater (including tidal influence and sea level rise), soil corrosion potential, lateral spreading, settlement, seismic design, foundations for shallow and deep structures, and support of pavement areas. Deep foundations, such as driven piles, cast-in-hole caissons, or auger cast piles may be required to support large, heavy facilities. Geotechnical recommendations for the backfill of the excavation created by the landfill removal should be developed during the planning phase for landfill removal.

5.2 Geoenvironmental

The Geoenvironmental data gaps at Recycle Hill include soil and groundwater data beneath the central portion of the site. The shallow groundwater around the site perimeter is monitored annually from wells G-20, G-21, and G-22 for the constituents discussed in Section 2.2.1 and additional sampling from these wells is not necessary; however, the soil and groundwater beneath the central portion of the site will require additional sampling to determine conditions that may pose an environmental risk during future site development.

There are two primary concerns related to the soil and groundwater beneath the site, 1) the potential exposure of site workers to chemical hazards, and 2) the handling and disposal of soil and groundwater waste during site development. To address these concerns, the condition of the soil and groundwater must be understood to the total depth of the site-development activities. For example, should site excavation or foundation drilling be necessary, the site developer should know what chemicals are present, at what concentration, and to what depth. Because we don’t currently know the depth to which site development activities will occur, we recommend a depth of 25 feet below ground surface be assessed for chemical constituents in the subsurface.

Because of the shallow groundwater at the site (typically less than 10 feet below grade), there are limited vadose zone soils to assess; however, soil samples should be collected from the ground surface to the groundwater interface at 5-foot intervals and submitted for chemical analysis for the constituents identified in Table 5-1, and any other constituents not listed in Table 5-1 that are detected during the landfill removal operations. The shallow soil samples should be collected from the geotechnical borings using split-barrel samplers in accordance with ASTM standards D1586 and D4547.

Shallow groundwater around the perimeter of the site is currently monitored in accordance with the post-closure maintenance plan (SCS 2012), as discussed in Section 2.2.1. Shallow groundwater conditions beneath the central portion of the site need to be assessed to demonstrate a complete understanding of the shallow groundwater conditions that may affect site development (i.e., site dewatering). As such, one shallow monitoring well in the central portion of the site, installed as part of the geotechnical investigation, should be sampled and analyzed for the same constituents as the annual post-closure groundwater monitoring program, and any other constituents that are identified during the landfill removal operations. Together with the three existing site groundwater monitoring wells, the site groundwater conditions can be fully assessed.

Table 5-1. Geoenvironmental Soil and Groundwater Analytical Recommendations

Media	Analyses
Soil	• Metals • Hydrocarbons (total volatile and semi-volatile) • Gasoline range organics and diesel range organics • Pesticides • Polychlorinated biphenyl (pcb) • Others, as identified during landfill removal operations
Groundwater	• Inorganic parameters: chloride, COD, BOD, ammonia, ammonia-nitrogen, total Kjeldahl nitrogen, nitrate + nitrile nitrogen, and total nitrogen • Organic parameters: total phenols, fuel additives (BTEX and MTBE), and VOCs • Others, as identified during the vadose zone soil sampling and landfill removal operations

Section 6: Closure

The conclusions and recommendations presented herein are based on evaluation and interpretation from review of available relevant past subsurface investigations conducted at the project site. These conclusions and recommendations are intended to be used solely by Valley Water and its consultants in the evaluation of the Recycle Hill site.

This report is based on the data available at the time of completion, and the project as described. Should additional data become available, these conclusions and opinions would need to be reassessed.

The discussion and conclusions presented in this report are professional opinions based on our understanding of the proposed project. The findings and professional opinions presented in this report are presented within the limits prescribed by the client, in accordance with generally accepted professional engineering and geologic practices. There is no other warranty, either express or implied.

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Attachment A: Geotechnical Exploration Plan

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GEOTECHNICAL CONSULTANTS, INC.
Geotechnical Engineering • Geology • Hydrogeology

GEOTECHNICAL AND GEOENVIRONMENTAL EXPLORATION PLAN
PROPOSED RECYCLED WATER PLANT
SUNNYVALE, CALIFORNIA

September 2018

Prepared for:

Brown and Caldwell
201 N Civic Drive #300
Walnut Creek, CA 94596

Owner:

Santa Clara Valley Water District
San Jose, CA

GTC Project No. SF18011

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Appendix A Daily Field Observation
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Appendix C Field Logging and Classification of Soil

1.0 INTRODUCTION AND PURPOSE

The work to be performed under this geotechnical and geoenvironmental exploration plan (GEP) is to carry out a geotechnical and geoenvironmental investigation to support the design and construction of proposed recycled water treatment facilities at Recycle Hill (the Site), adjacent to the Sunnyvale Water Pollution Control Plant (WPCP). The proposed recycled water facilities may be located adjacent to a proposed new WPCP administration building at the same site. The contents of this GEP should be modified, as necessary, to accommodate the design of future facilities as the overall planning and conceptual layout of the facilities progresses.

This GEP has been prepared under our geotechnical services task order under contract with Brown and Caldwell (BC) for the Geotechnical Preliminary Study: Recycle Hill, Subtask 3.2 of the Countywide Water Reuse Master Plan (CWRMP) project. The investigation addressed in this plan is intended to gather the necessary information and data to satisfy the following primary objectives:

- Provide geotechnical and geoenvironmental parameters for our site evaluation;
- Assess any potential geologic hazards at the site including strong ground shaking, liquefaction, lateral spread, and dynamic settlement, and;
- Develop foundation recommendations to support the design of new foundations as necessary.

This GEP provides: 1) the scope of the field exploration work, 2) the terms and procedures for logging, sampling, and analysis of soil encountered, and 3) disposal of investigation derived waste. This GEP also describes general field procedures and documentation, including:

- Permits and coordination
- Traffic control
- Utility clearance
- Daily field reports

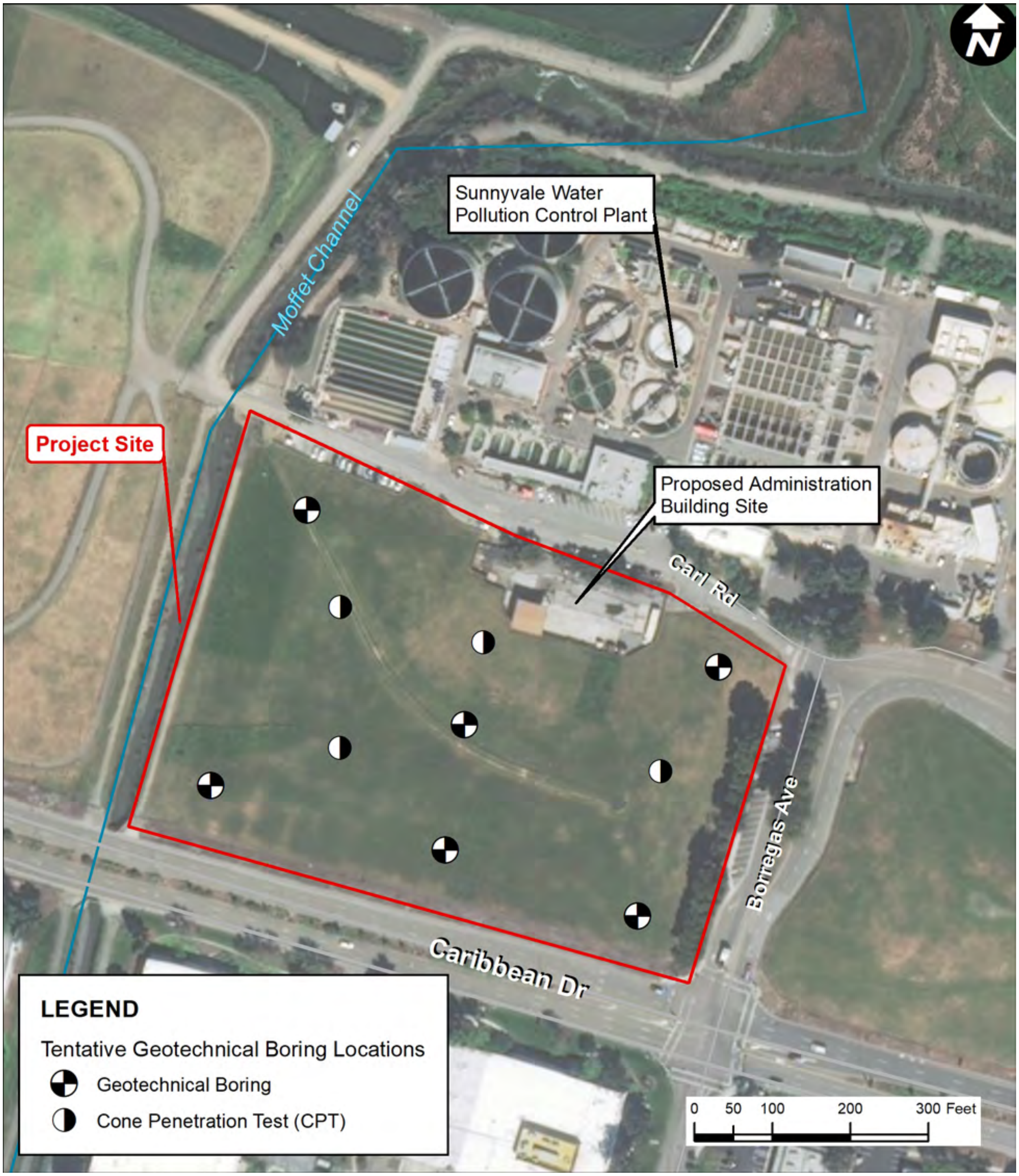
N
Sunnyvale Water Pollution Control Plant
Moffet Channel
Project Site
Proposed Administration Building Site
Carl Rd
Borregas Ave
Caribbean Dr
LEGEND
Tentative Geotechnical Boring Locations
Geotechnical Boring
Cone Penetration Test (CPT)
0
50
100
200
300 Feet

Figure 1 – Proposed Exploration Plan

2.0 SITE SETTING

The project location is known as Recycle Hill and is one of four mounds of the closed Sunnyvale Municipal Landfill. The GEP anticipates the landfill waste, cover soils, and various appurtenances (leachate and gas collection systems) will be removed prior to site investigation activities. The general area is generally flat-lying except for the landfill mounds and the channel levees along the Moffett Channel located on the west side of the site.

3.0 GEOLOGIC SETTING AND GEOTECHNICAL/GEOENVIRONMENTAL ISSUES

3.1 GEOLOGIC SETTING

The project site at Recycle Hill is located at the north end of broad alluvial fans that slope gently to the north from highland areas surrounding the southern Santa Clara Valley. The Holocene age alluvial deposits formed on a broad flat plain at the margin of San Francisco Bay are distinctly fine-grained sand, silt and clay and referred to as alluvial fan and basin deposits (Brabb etal, 2000). The site is underlain by silty clay fan deposits that merge northward (and locally overlie) with estuarine organic clay and silty clay generally referred to as Bay Mud. The alluvial fan basin deposits in the project area contain carbonate nodules or concretions and iron staining indicative of the mixing of fresh water and seawater at the bay margin interface (Brabb etal, 2000). Basin deposits are very fine silty clay deposits that reached the distal edge of the alluvial fan.

The project site is bounded on the west by artificial levees that border Moffett Channel that drains northward between salt ponds to reach Guadalupe Slough. Recycle Hill is a 40-foot high mound representing one of four cells of the closed City of Sunnyvale municipal solid waste landfill. Nearby geotechnical borings encountered 9 to 14 feet of artificial fill overlying lean clay, lean clay with sand, and sandy lean clay. The clay deposits represent the Holocene distal alluvial fan deposits (SCI, 1992; Fugro, 2016). Soft bay mud was not encountered in these borings located on the north side of Recycle Hill or in borings located 500 feet north within WPCP (Fugro, 2016).

3.2 GEOTECHNICAL/GEOENVIRONMENTAL ISSUES

Given the project site geologic setting and engineering objectives, the Project may be exposed to potential geologic/seismic hazards and design challenges that will require evaluation during the investigation. Based on our understanding of the proposed project and the conditions at the project site, the following key geotechnical/geoenvironmental issues have been identified:

- Potential geologic and seismic hazards including strong ground shaking, liquefaction, and dynamic settlement;
- The presence of loose and undocumented artificial fill;
- The presence of weak clay layers;
- The presence of saline groundwater;
- Control of shallow groundwater in excavations or deep foundation boreholes;
- Mitigation of potentially corrosive soils;
- The presence of potentially hazardous chemicals in the subsurface soils and groundwater.

To address these issues, the primary objectives of the proposed study and laboratory testing program are to:

- Collect subsurface information necessary for design of the proposed structures. Identify index (classification) and engineering properties of soils for use in development of geotechnical design parameters including bearing capacity, lateral earth pressures, base and wall friction, side resistance and end bearing for drilled shafts, etc.;
- Collect samples for corrosion testing;
- Identify subsurface conditions that may affect excavation and drilling of deep foundation boreholes or driving piles, including areas of soft, loose, or otherwise potentially-unstable soils; and high groundwater, and;
- Identify depth to, and thickness of, dense bearing stratums for the planning and design of deep foundation schemes;
- Collect soil and groundwater samples to assess the presence of potentially hazardous chemical concentration that could impact site development activities.

The scope of the field investigation and laboratory testing program described in the following sections has been developed to accomplish the objectives summarized above. The overall study consists of researching available data, conducting field investigation activities, performing laboratory tests, and developing and analyzing data.

4.0 INVESTIGATION WORK SCOPE

The field investigation program will consist of up to 4 to 6 cone penetration tests (CPTs) and 6 to 8 borings to maximum depths of 150 to 200 feet, the collection of soil and groundwater samples, and associated field and laboratory tests to obtain necessary data to support the evaluation of the site and design of proposed facilities. The approximate boring and CPT locations are shown on ***Figure 1 – Proposed Exploration Plan***. The details of the exploration program, including the location of the borings, permit requirements, and sampling schedule, are discussed in the following sections.

The investigation work to be carried out will consist of:

- ***Drilling:*** A total of 6 to 8 borings are planned to characterize soil and groundwater conditions across the site. Locations as shown may be refined through further planning of the proposed site facilities. The depth at which groundwater is encountered will be noted on the borehole logs. Groundwater levels will be estimated during drilling. Borings not converted to piezometers will be backfilled with cement grout. Asphalt surfaces will be repaired with cold patch asphalt or concrete as appropriate.

- ***Sampling:*** Samples of soil and consolidated formation will be logged by an experienced engineer or geologist. Soil samples will be obtained for visual classification and laboratory testing using standard penetration testing (SPT) split spoon or modified California drive samplers, or relatively undisturbed thin-walled Shelby tube samplers as appropriate. Sampling will typically be done at 5-foot intervals.

- ***Piezometers:*** Piezometers will be installed in both the shallow and deeper aquifer units beneath the site to monitor seasonal and tidal fluctuations in groundwater levels. A minimum of three deep soil borings will be converted to piezometers, and a minimum of one shallow piezometer will be installed at the center of the site for environmental sampling of groundwater. The central shallow piezometer will supplement the data generated from existing shallow piezometers G-20, -21, and -22. Details of piezometer installation including the quantity, depth and design will be determined in the field based on observed site conditions and project requirements. Groundwater samples from piezometers will be collected as appropriate for the geoenvironmental analysis.

- ***Cone Penetration Testing*:** A total of 4 to 6 CPTs are planned to supplement the boring exploration to characterize soil and groundwater conditions across the site. The proposed approximate locations of the CPTs are shown on ***Figure 1***. Locations as shown may be refined through further planning of the proposed site facilities.

- ***Geotechnical Laboratory Testing:*** Select soil samples will be tested in a geotechnical laboratory for index properties and physical characteristics including Atterberg limits, grain size distribution, moisture content, unit weight, swell pressure, consolidation, shrink-swell potential, shear/compressive strength among other tests dependent on project requirements and soils encountered. In addition, select samples will be tested for their corrosion potential towards concrete and ferrous metals.

- ***Geoenvironmental Laboratory Testing:*** Select soil samples will be tested for the following constituents: metals, hydrocarbons, gasoline range organics, pesticides, PCBs and others as identified during landfill removal operations. In addition, groundwater will be sampled from shallow piezometers and tested for organic and inorganic parameters associated with the landfill removal process. A detailed geoenvironmental testing schedule is outlined in Section 5.2 of the attached Technical Memorandum 3.2.

5.0 GENERAL FIELD PROCEDURES AND DOCUMENTATION

This section describes the procedures that will be used to accomplish the field program for the Project. Permits, procedures for utility clearances, safety of field personnel, environmental monitoring, reporting of daily activities, restoration of exploration sites, and borehole logging are described.

5.1 PERMITS AND COORDINATION

The boring locations will be located within the Recycle Hill site. Soil boring / well permits for the subsurface exploration program will be obtained from Santa Clara County including necessary SCVWD permits. With geotechnical borings occurring after removal of the landfill material, additional permits related to landfill drilling are not anticipated.

5.2 TRAFFIC CONTROL

Traffic control is not anticipated as each boring or CPT will be located within the Recycle Hill project site.

5.3 UTILITY CLEARANCE

The borings will be located in areas having the greatest potential for clearance from overhead and underground utilities. All boring locations will be clearly marked with white paint or white stakes. If underground utilities are anticipated in the vicinity of a marked boring, a private utility locator service will be called on site to locate and delineate underground utilities so that the boring can be cleared or relocated as necessary. Underground Services Alert (USA) will be notified of the field activities approximately 1 week prior to the start of the work. As a further degree of safety, all borings where utility conflicts are suspected will be hand augered to at least 5 feet below existing grade to avoid drilling through any unlocated or miss-located utility.

Site plans showing proposed boring locations should be submitted to the City of Sunnyvale for review and clearance at least 1 week prior to drilling. Drilling will commence only after receiving clearance from the private subsurface utility locator, USA, and permitting agencies.

5.4 HEALTH AND SAFETY

All work performed will comply with the Project-specific Site Health and Safety Plan (HASP), to be developed with the project team and the project Owner. Special consideration for the nature of the decommissioned landfill site may be required when developing the HASP.

5.5 DAILY FIELD REPORTS

Daily Field Reports (DFR) will be prepared to document fieldwork. All reports will be prepared on standardized DFR forms (see sample form in Appendix A). The following information should be included as appropriate in the entries: Project number and task designation; date; Project name; field activity/work performed; location; weather; names of field personnel on site and observers (i.e., clients, technical persons from other firms, county representatives, etc.); completed safety tailgate meetings; supplies used (such as casing, cement, mud, etc.); and other pertinent information (e.g., difficulties, unusual or unexpected conditions).

6.0 BORING PROCEDURES

Borings will be used to explore subsurface conditions within the Project site and to obtain samples for laboratory testing. Locations of the borings are shown on ***Figure 1***. The general procedures for logging and sampling the borings are described below.

6.1 PREPARATION AND RESTORATION OF BORING SITES

In general, borings will be located near to those indicated in ***Figure 1***, or as relocated after preliminary facility layouts are developed. Locations will be selected to maximize the safety of field crews and to minimize impacts on existing site facilities, site access, drainage, landscaping, and native vegetation.

Borings will be backfilled with cement grout. Asphalt surfaces will be repaired with an asphalt cold patch or grouted to the surface as appropriate. The pavement surface will be swept clean.

6.2 DRILLING

Borings within the Project site will be drilled using either mud-rotary or sonic drilling equipment. Drilling fluid will be used during mud-rotary operation.

6.3 LOGGING

All borings will be logged by or under the direct supervision of a Professional Geologist or Professional Engineer registered in the State of California. The geologist/engineer will record daily activities and document significant field observations on a daily field log (refer to Appendix A). The geologist/engineer will log the drill-holes on a field log (see Appendix B) in accordance with the guidelines for soil and/or rock logging presented in Appendix C and D of this document; these guidelines are based on information contained in field manuals developed by the U.S. Bureau of Reclamation (1998) and by Caltrans (1995). During drilling operations, sample depths will be recorded in Imperial units.

All the information in the title block of the boring log will be filled out (refer to Appendix B). The ground surface elevation at the top of borehole will be estimated at the time of drilling, and updated after a field survey is completed. Ground surface elevation can be estimated from existing topographic maps or referenced to a permanent marker in the field. Estimates of elevation should be made to the nearest 2 feet. If an estimate is made, it should be so noted on the logs as such. The boring log title block requires the name of the drilling company. Names of the drill rig crew will be noted on the DFR. In addition, the starting and ending time of the boring will be recorded in the remarks column.

The depth where groundwater is first encountered while drilling, and the depth at the completion of drilling, will be recorded on the log.

6.4 SAMPLING AND DESCRIPTION OF SOIL

Soil will be sampled by either drive sampling or push sampling. Soil samples will be described according to Appendix C – Field Logging and Classification of Soil. When a hammer is used to drive the sampler, the following information will be recorded: delivery system; sampler size; whether or not inner brass tubes are used; and blow counts (recorded in 6-inch intervals). Whenever possible, a safety hammer will be used when driving samplers and measuring blow counts. When push sampling, Shelby or Pitcher tube size and maximum downfeed pressure (read from gauges on the drill rig) should be recorded. In all cases, the amount of sample recovery should be noted.

Typically, samples will be taken at 5-foot intervals throughout the total depth of the boring. In zones where the soil is transitioning from fill material to native soil, or between native soil formations, the sampling interval will be reduced if necessary to characterize the transition zone. Some borings may require different sampling intervals. To the extent possible, modified California Samplers (2 ½ inch ID, 3 inch OD, with liners) and/or Shelby tubes (3 inch OD) will be used to sample cohesive soils. The standard penetration sampler (1.375 inch ID, 2 inch OD, without liners) will be used in cohesionless soils.

Modified California drive and standard penetration (SPT) samplers will be driven into the soil with a 140 lb automatic trip hammer falling 30 inches in general accordance with ASTM 1586. The sampler will be driven 18 inches or to “refusal” (50 blows for less than 6 inches penetration). The blow counts for the final 12 inches of the drive, or portion thereof, will be recorded in the field log.

All samples will be clearly labeled with the following:

- sample number
- job number
- borehole number
- date and time collected
- initials of person collecting the sample.

The sample numbering system consists of two numbers. The first number refers to the sampling interval number. The sampling interval number refers to the driving of the SPT or modified California samplers 18 inches or a portion thereof, or the pushing/drilling of Shelby/Pitcher sampler. These will be numbered consecutively from the top of the borehole to the bottom (Appendix B). Sampling intervals will be numbered even if there is no recovery.

The second number is only used when brass or stainless steel liners are used in the sampler; it refers to the tube number in the sampler. The second number typically applies to the modified California samplers (may also be used for an SPT sampler with liners). For a 24-inch sampler, the liner tube closest to the shoe of the sampler is referred to as tube No. 4. The tubes above it are then labeled consecutively upward as 3, 2, and 1. Although most modified California samplers use three 6-inch tubes, there are some that use four.

6.5 SAMPLING AND DESCRIPTION OF ROCK

Rock is not expected at the Recycle Hill site. Should cemented layers be encountered, we will obtain samples using either soil sampling methods, or a Pitcher barrel sampler, which retrieves a core sample in a 3 inch OD steel liner very similar to a Shelby tube liner.

6.6 BOREHOLE COMPLETION

Unless converted to a piezometer, boreholes will be backfilled with cement grout. The grout mixture will meet the requirements of the local agency. If groundwater is encountered in the borehole, grout will be placed using the tremie method. The tremie method involves pumping grout through the drill rods or a tremie pipe to the bottom of the hole. The drill rods and/or auger/casing will be removed as grout is being pumped; the bottom of the drill rods/casing must be submerged in the grout at all times. The removal of the rod/casing should not begin until grout comes out the top of the borehole. Normally, grout should be tremied through the drill rods or tremie pipe via the drill rig pumping system. In the absence of a pump on the drill rig, the grout will be tremied through a PVC pipe that extends to the bottom of the hole. The grout will be funneled into the top of the PVC. After grouting is complete, the upper 6 to 12 inches of the borehole will be finished with native soil, cold patch asphalt, or quickrete as appropriate. The borehole should be checked in a day or two to make sure it has not settled significantly, and if it has, it will be restored to existing grade.

6.7 PIEZOMETER INSTALLATION

Piezometers will be installed in accordance applicable regulations, and will consist 2-inch diameter, Schedule 40 PVC well casing and screen (factory slotted with 0.02-inch-wide slot size), with No. 3 sand (or approved alternative) filter pack placed within the annulus of the screened interval of the borehole. The screened interval will be isolated from the rest of the boring by a bentonite seal to ensure that the screened interval monitors only the desired groundwater zone. The borehole above the bentonite seal will be filled with grout to the ground surface. The piezometer casing will be installed below the adjacent ground surface. The piezometer will have a locking cap and will be installed with a traffic-proof Christy Box for a “flush-mount” finish, or a steel locking riser casing for “above-ground” finish.

6.8 DRILL CUTTINGS

Drill cuttings and drilling fluid will be stored in 55-gallon steel drums or larger temporary storage bins pending testing, pick-up, and proper disposal by an environmental waste subcontractor. The subcontractor will determine appropriate testing protocol to facilitate disposal. Drums will be labeled with drill-hole number, date, and initials of rig geologist or engineer.

7.0 CONE PENETRATION TESTS (CPTS)

Cone Penetration Tests (CPTs) will be completed by a CPT subcontractor and will follow standard ASTM D5778 procedures. The test is carried out by first pushing the cone, which consists of a stainless steel probe comprising a cone tip and a friction sleeve, into the ground at a standard velocity of 1 to 2 cm/s. The cone takes measurements of cone tip bearing (qc), sleeve friction (fs) and penetration pore water pressure at 5- cm intervals during penetration to provide a nearly continuous hydrogeologic log. CPT data reduction and interpretation is performed in real time and the tip and sleeve resistance parameters are stored electronically for further analysis and reference.

The cone also contains a porous filter element located directly behind the cone tip which is used to obtain penetration pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (PPDT’s) during appropriate pauses in penetration in order to estimate groundwater piezometric pressures at any depth.

When the soundings are complete, the test holes will be grouted. The grouting procedures generally consist of pushing a hollow CPT rod with a “knock out” plug to the termination depth of the test hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. The top of the CPT hole will be finished with either a concrete or asphalt surface patch, or with native soil as appropriate.

8.0 SCHEDULE

The field investigation schedule will be determined at a later date pending decisions regarding site development and use. It is anticipated that each boring may be drilled in one to one and a half days, and that CPTs may be pushed at a rate of up to 4 per day. After permits are in place, and drill rig availability is confirmed, a detailed work schedule will be prepared and submitted to the Project Team. Daily field activities involving heavy drilling equipment are planned for Monday-Friday, between approximately 7:00 am to 5:00 pm. After completion of field work, it is anticipated that laboratory testing will take approximately one month to complete.

All exploration results, laboratory test results and geotechnical/geoenvironmental summaries of the data should be presented in a final report. The final reports should also include geotechnical and geoenvironmental recommendations that support the foundation design and construction of the proposed facilities.

REFERENCES:

Brabb, E.E., Graymer, R.W., and Jones, D.L., 2000, Geologic Map of the Palo Alto 30’ x 60’ Quadrangle, California, U.S. Geological Survey Miscellaneous File No. 2332.

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Appendix F: Conceptual Alternatives

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Appendix F-1: Conceptual Alternatives

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Technical Memorandum

Prepared for:	Santa Clara Valley Water District (Valley Water)
Project title:	Countywide Water Reuse Master Plan
Project no.:	4821 (Valley Water); 151772 (BC internal)
Contract no.:	A4120A

Appendix F

Subject:	Conceptual Alternatives
Date:	October 9, 2018 (reissued June 30, 2020)
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Limitations:

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List of Abbreviations

ADWF	average dry weather flow
AFY	acre-foot/feet per year
AWPF	advanced water purification facility
Cal Water	California Water Service Company
CIP	capital improvement program
County	Santa Clara County
DAC	disadvantaged community
DPR	direct potable reuse
DWR	Department of Water Resources
FSRWE	*Feasibility Study for Recycled Water Expansion*
GHG	greenhouse gas
GW	groundwater
GWR	groundwater recharge
IPR	indirect potable reuse
L	liter(s)
LGRP	Los Gatos Recharge Ponds
Master Plan	*Countywide Water Reuse Master Plan*
MF	microfiltration
mg/L	milligram(s) per liter
MG	million gallons
mgd	million gallons per day
MPU	*Master Plan Update*
N/A	not applicable
NASA	National Aeronautics and Space Administration
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NPR+	enhanced non-potable reuse
O&M	operations and maintenance
PA/MV	Palo Alto/Mountain View
PPG	Project Partner Group
PR	potable reuse
Reclamation	U.S. Bureau of Reclamation
RO	reverse osmosis
ROC	reverse osmosis concentrate
RWF	regional wastewater facility
RWFE	*Recycled Water Feasibility Evaluation*
RWFP	*Recycled Water Facility Plan*
RWFS	*Recycled Water Feasibility Study*
RWMP	*Recycled Water Master Plan*
RWQCP	Regional Water Quality Control Plant
RWS	recycled water system
SBWR	South Bay Water Recycling
SCP	Silver Creek Pipeline
SCRWA	South County Regional Wastewater Authority
SJMWS	San José Municipal Water System
SJ/SC RWF	San José-Santa Clara Regional Wastewater Facility
SJW	San Jose Water[1]
SMP	*Strategic and Master Plan*
SVAWPC	Silicon Valley Advanced Water Purification Center
TDS	total dissolved solids
TM	technical memorandum
UWMP	urban water management plan
Valley Water	Santa Clara Valley Water District
WPCP	water pollution control plant
WSMP	*Water Supply Master Plan*
WTP	water treatment plant
WWTP	wastewater treatment plant

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[1] San Jose Water does not use an accent in its name, though City of San José does.

Executive Summary

The Santa Clara Valley Water District (Valley Water) initiated the Countywide Water Reuse Master Plan (Master Plan) to improve water supply reliability through water reuse for Santa Clara County (County). Valley Water is building on its partnerships with four non-potable reuse (NPR) systems in the county, referred to as Partner Agencies:

- Palo Alto/Mountain View (PA/MV) Recycled Water System (RWS)
- Sunnyvale RWS
- South Bay Water Recycling (SBWR)
- South County Regional Water Authority (SCRWA)

The conceptual alternatives evaluation assesses the County's water reuse market, identifies conceptual project alternatives, and evaluates the alternatives through a prioritization and assessment methodology. The purpose of this deliverable is to select three alternatives to move forward for feasibility evaluation. This is intended as an interim deliverable; alternatives (also called "project elements and portfolios") will be refined as the project evolves.

Market Assessment

Among other objectives, the Master Plan aims to identify opportunities for potable reuse (PR) development and NPR expansion in the county, and the optimal split between PR and NPR. To identify, locate, and quantify potential future NPR demand in the County, Valley Water performed an NPR market assessment using 2035 projections from the water retailers' 2015 urban water management plans (UWMP). The one exception is the City of Morgan Hill (within the SCRWA service area), whose 2015 UWMP projected zero long-term NPR deliveries. Because an NPR project in Morgan Hill may be feasible in the context of a larger, countywide plan, Valley Water will evaluate NPR alternatives in this Technical Memorandum (TM). Thus, the following analysis uses Morgan Hill's conceptual buildout demands from the 2015 South County Recycled Water Master Plan Update.

Demand projections by Partner Agency, as summarized in Table ES-1, provide a basis for developing conceptual alternatives to meet future demands. NPR demand projections do not fully capture potential allocations per contractual agreements. For example, the City of Palo Alto is contractually obligated to provide up to 3 million gallons per day (mgd) of recycled water to the City of Mountain View, but projected NPR demands are less than 3 mgd. This analysis assumes future NPR usage aligns with the projections shown in Table ES-1; however, some Partner Agencies are in the process of updating their projected NPR demands. If finalized in time, these revised projections will be incorporated into the Master Plan.

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Table ES-1. Summary of Projected Long-Term NPR Demands by Partner Agency

Partner Agency	Water Retailers	2035 NPR Demand, mgd (AFY)[a]	Current Contractual Obligation[b]
PA/MV RWS	City of Palo Alto City of Mountain View	2.5 (2,800)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	City of Sunnyvale California Water Service Company (Cal Water) (Cupertino) San Jose Water (Cupertino)	1.5 (1,700)	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	City of Santa Clara San José Municipal Water System (SJMWS) San Jose Water City of Milpitas	21.5 (24,100)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA	City of Gilroy City of Morgan Hill	3.3 (3,700) 2.6 (2,900)[c]	N/A
County Total		31.5 (35,200)	

a. *Projected 2035 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY. For the City of Morgan Hill, NPR demand is equal to the conceptual buildout demand identified in the 2015 South County Recycled Water Master Plan Update. Updated NPR demand projections from Partner Agencies will be incorporated into the Master Plan if/when available.*

b. *Projected NPR demands do not fully capture potential allocations per contractual agreements.*

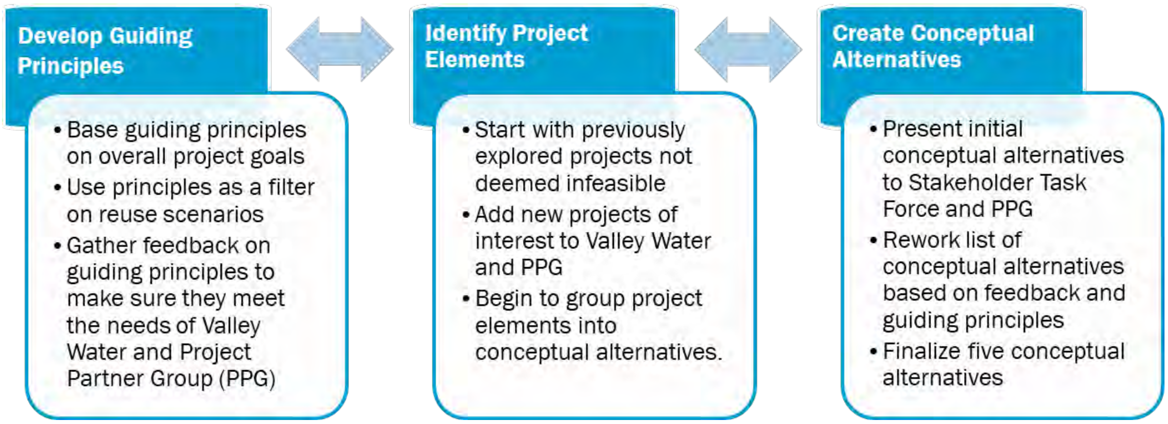
c. *Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.*

mgd = million gallons per day

AFY = acre-foot/feet per year

Conceptual Alternatives Development

Figure ES-1 illustrates the process used to develop conceptual alternatives for the Master Plan.



Develop Guiding Principles

- Base guiding principles on overall project goals
- Use principles as a filter on reuse scenarios
- Gather feedback on guiding principles to make sure they meet the needs of Valley Water and Project Partner Group (PPG)

Identify Project Elements

- Start with previously explored projects not deemed infeasible
- Add new projects of interest to Valley Water and PPG
- Begin to group project elements into conceptual alternatives.

Create Conceptual Alternatives

- Present initial conceptual alternatives to Stakeholder Task Force and PPG
- Rework list of conceptual alternatives based on feedback and guiding principles
- Finalize five conceptual alternatives

Figure ES-1. Process used to develop conceptual alternatives

Development of conceptual alternatives was guided by the following principles:

- Consider previously explored projects (not previously deemed infeasible, unless circumstances have changed) and new projects
- Reflect a mix of NPR and PR projects
- Aim to develop at least 24,000 AFY of PR supply by 2028 to meet the County's water supply demands (per Valley Water's 2019 Water Supply Master Plan [WSMP] 2040)
- Expand countywide NPR and/or PR using source water from each of the Partner Agencies
- Leverage existing infrastructure where possible

The alternatives include a mix of potential project elements, including some previously proposed projects (from various recycled water master plans [RWMP]) and some new elements. Based on Partner Agency input, Valley Water developed the following five conceptual alternatives for evaluation:

- **Alternative 1:** indirect potable reuse (IPR) (from San José-Santa Clara [SJ/SC]) and expanded NPR
- **Alternative 2:** IPR (from Palo Alto/Sunnyvale) and expanded NPR
- **Alternative 3:** IPR (from Palo Alto and Morgan Hill) and expanded NPR
- **Alternative 4:** IPR (from Palo Alto/Sunnyvale and Morgan Hill) and expanded NPR
- **Alternative 5:** IPR (from Morgan Hill), direct potable reuse (DPR) (from SJ/SC), and expanded NPR

Each alternative has a unique set of pros and cons, which were considered during the alternatives ranking and selection process. Table ES-2 lists the pros and cons common to all five conceptual alternatives, as well as those for each alternative.

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Table ES-2. Pros and Cons of Conceptual Alternatives

Alternative	Pros	Cons
All Alternatives	• Reduced discharge to San Francisco Bay / Monterey Bay • Enhanced NPR across entire North County (PA/MV RWS, Sunnyvale RWS, and SBWR) • Interties (especially bi-directional) increase reliability and operational flexibility • Decreased dependence on imported water • Local supplies offsetting imports could reduce greenhouse gas (GHG) overall	• Reverse osmosis (RO) concentrate management challenges • Interties will require new agreements • Environmental impacts of construction
Alternative 1	• Increased reliability throughout county from enhanced NPR interties • Augments groundwater (GW) supply from single facility • Separate advanced water purification facilities (AWPF) allow for streamlining implementation • Known treatment technologies	• Capital and operations and maintenance (O&M) costs related to 3 new AWPFs (34,900 AFY combined purified water capacity), 3 interties, and new Morgan Hill enhanced NPR distribution system • Significant pumping and pipe requirements for SBWR-Morgan Hill connection • Agreements required for multiple interties • Silver Creek Pipeline (SCP) agreement may expire
Alternative 2	• Increased reliability throughout county from enhanced NPR interties • Augments GW supply from regional AWPF (served by the Palo Alto Regional Water Quality Control Plant [RWQCP] and Sunnyvale Water Pollution Control Plant [WPCP]), which has greater feed reliability than an AWPF served by the Sunnyvale WPCP alone • Known treatment technologies	• Capital and O&M costs related to 2 new APWFs (34,900 AFY combined purified water capacity), 3 interties, and new Morgan Hill enhanced NPR distribution system • Regional AWPF in Sunnyvale complicates permitting • Regional AWPF limits feed to Palo Alto AWPF, which could limit NPR expansion in PA/MV and Sunnyvale • Significant pumping and pipe requirements for SBWR-Morgan Hill connection • Requires two transmission pipelines between PA/MV and Sunnyvale for AWPF influent and enhanced NPR • Agreements required for multiple interties • SCP agreement may expire • Limited agency experience in IPR via groundwater recharge (GWR)
Alternative 3	• Increased reliability for Sunnyvale and SBWR • Augments GW in North and South counties, each from a single facility • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP • Separate AWPFs allow for streamlining implementation • Known treatment technologies	• Capital and O&M costs related to 3 new APWFs (26,900 AFY combined purified water capacity, including Morgan Hill) and 1 intertie • Greater distance between Palo Alto and Los Gatos Recharge Ponds (LGRP) than between SJ/SC and Sunnyvale facilities • Less water to LGRP than Alternatives 1 and 2 • Larger AWPF in Palo Alto requires more land than other alternatives • PA/MV system remains separate, limiting NPR expansion in PA/MV • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Diverting flow in Morgan Hill during higher NPR demand periods could require supplemental water supply in Gilroy area (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations • Limited agency experience in IPR via GWR

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Table ES-2. Pros and Cons of Conceptual Alternatives

Alternative	Pros	Cons
Alternative 4	• Increased reliability for PA/MV and Sunnyvale from enhanced NPR intertie • Augments GW supply from regional AWPF (fed by the Palo Alto RWQCP and Sunnyvale WPCP), which has greater feed reliability than an AWPF fed by the Sunnyvale WPCP alone • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP • Known treatment technologies	• Capital and O&M costs related to 3 new AWPF (36,700 AFY combined purified water capacity, including Morgan Hill) and 1 intertie • Regional AWPF in Sunnyvale complicates permitting • Regional AWPF limits feed to Palo Alto AWPF, which could limit NPR expansion in PA/MV and Sunnyvale • SBWR remains separate, limiting NPR expansion in San José • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Diverting flow in Morgan Hill during higher NPR demand periods could require supplemental water supply in Gilroy area (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations • Limited agency experience in IPR via GWR
Alternative 5	• Increased reliability in North County from enhanced NPR interties • Greater reliability for potable water than the other alternatives • Augments GW from single facility and agency experienced in GWR • Separate AWPFs streamline implementation • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP	• Capital and O&M costs related to 4 new AWPFs (39,600 AFY combined purified water capacity, including Morgan Hill) and 2 interties • Costly improvements for DPR and purified water production capacity and monitoring (highest of all alternatives) • DPR regulations are not yet established • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Unknown additional technologies for achieving DPR level of treatment • Diverting flow in Morgan Hill during higher NPR demand periods could require supplemental water supply in Gilroy area (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations

Note: This is not an exhaustive list. Some criteria, such as cost, greenhouse gas emissions, or other, may appear as a pro or a con, depending on the alternative.

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The conceptual alternatives are not defined at the level of detail needed to estimate utilization, which depends on a number of factors, including:

- Local groundwater conditions
- Water system operations (e.g., flow balancing)
- Recovery rates and reverse osmosis concentrate (ROC) management options
- Local water rights and source priorities
- Water demands

Estimated utilization rates, and how the rates may vary temporally, will be considered in the feasible portfolios evaluation.

The supply available for purified water in 2035 was calculated based on projected NPR demands, losses, and environmental flow requirements, as well as the amount of effluent needed for enhanced NPR (also known as NPR+). NPR+ involves blending purified water (full-advanced treatment or equivalent water quality) with Title 22 recycled water for total dissolved solids (TDS) reduction, targeting a maximum TDS of 500 milligrams per liter (mg/L) in the NPR+ system (see Attachment B for more details). Valley Water is assuming full advanced treatment—including associated recovery rates—at all advanced water purification facilities listed in Table ES-2; however, Valley Water is also exploring the feasibility of alternative treatment trains, which may result in increased recovery rates.

In this analysis, it was assumed that remaining effluent (i.e., plant influent minus NPR demands, losses, and environmental flows) would be available as feed water for an AWPF; blending or discharge requirements will be further considered as the Master Plan progresses, along with potential new contractual agreements. Available PR supply was calculated using assumed recovery rates for advanced treatment. A PR flow balance was completed by allocating the available purified water to each recharge pond or water treatment plant (WTP) that would receive PR in each conceptual alternative. Table ES-3 compares estimated purified water flows among alternatives, rounded to the nearest 100 AFY. These estimates are preliminary; source water flow projections may be refined as new information (e.g., updated NPR demand projections) becomes available.

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Table ES-3. Preliminary Estimate of Purified Water Available for PR Alternatives

Supply Source	Source Water Available for PR, Considering Treatment Losses[a] (AFY)	Purified Water Provided for PR (AFY)[b]				
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Palo Alto RWQCP	14,100[c]	0	14,000	14,100	14,000	0
Sunnyvale WPCP	10,300[c]	0	10,000	0	10,000	0
SJ/SC Regional Wastewater Facility (RWF) • With Morgan Hill NPR+ [d] • Without Morgan Hill NPR+	71,800[e] 74,300[e]	24,000 N/A	0 N/A	N/A 0	N/A 0	N/A 26,900
SCRWA Service Area • Potential Future Morgan Hill AWPF and Satellite Plant	2,800	0	0	2,800[f]	2,800[f]	2,800[f]
County total • With Morgan Hill NPR+ [d] • Without Morgan Hill NPR+	99,000 101,500	24,000 24,000	24,000 24,000	17,000[g] 17,000[g]	26,800 26,800	29,700 29,700
PR locations		LGRP	LGRP	LGRP, South County recharge ponds	LGRP, South County recharge ponds	Penitencia WTP, South County recharge ponds

a. *Assumes that all remaining effluent is available as feed water for an AWPF; blending or discharge requirements will be further considered as the Master Plan progresses, along with potential new contractual agreements. Treatment losses account for advanced treatment recovery rates.*

b. *Purified water provided is limited to recharge capacity or treatment capacity of receiving facility.*

c. *Based on high estimates of future losses and potential environmental flows.*

d. *Alternatives 1 and 2 include Morgan Hill NPR+. Alternatives 3, 4, and 5 do not.*

e. *Per the assumptions in the Baseline Analysis TM, no potential environmental flows were considered for SJ/SC RWF.*

f. *Delivered to recharge ponds in South County; exact location TBD.*

g. *Difference due to rounding.*

N/A = not applicable.

Process and Outcomes of Alternatives Assessment

Valley Water developed criteria and weighting factors to evaluate the conceptual alternatives. Criteria were initially developed based on objectives of the Master Plan and those common to U.S. Bureau of Reclamation and Department of Water Resources funding opportunities, and then refined based on Partner Agencies' input. Each alternative was awarded a score between 1 (unable to satisfy requirements) and 5 (fully satisfies requirements) for each criterion. The criteria, weighting, and scores for each alternative are shown in Table ES-4.

Table ES-4. Conceptual Alternative Scoring

Criterion	Weighting	Conceptual Alternative Scores				
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Economics	25%	3.0	3.0	2.0	3.0	1.0
Groundwater management and countywide (regional) supply reliability	25%	3.0	3.0	2.0	4.0	5.0
Environmental impacts/benefits and sustainability	20%	4.0	4.0	3.0	4.0	2.0
Ease of implementation and permitting/regulatory considerations	15%	5.0	4.0	2.0	3.0	1.0
Engineering feasibility	15%	4.0	4.0	3.0	3.0	1.0
Total		3.7	3.5	2.4	3.5	2.2

Based on the results of the scoring process, the top three alternatives include:

- **Alternative 1**: IPR (from SJ/SC) and expanded NPR
- **Alternative 2**: IPR (from Palo Alto/Sunnyvale) and expanded NPR
- **Alternative 4**: IPR (from Palo Alto/Sunnyvale and Morgan Hill) and expanded NPR

These alternatives will be refined and further evaluated in the feasible portfolios evaluation.

Other Considerations and Next Steps

The three alternatives selected to move forward to feasible portfolios evaluation will be developed to a preliminary (10 percent) design and further evaluated using detailed prioritization criteria and other factors, such as economics, environmental impacts/benefits, governance considerations, and risk.

Valley Water will continue to facilitate meetings and workshops with the PPG, Executive Leadership Group, Stakeholder Task Force, and the Valley Water Board of Directors' Recycled Water Committee to discuss and refine the Draft Master Plan Report. The Final Master Plan Report will be developed in close coordination with these partners and stakeholders.

Section 1: Introduction

The Santa Clara Valley Water District (Valley Water) initiated the Countywide Water Reuse Master Plan (Master Plan) to improve water supply reliability through water reuse for Santa Clara County (County). Valley Water is building on its partnerships with four non-potable reuse (NPR) systems in the county, referred to as Partner Agencies, to integrate existing plans and infrastructure. The Partner Agencies include:

- Palo Alto/Mountain View (PA/MV) Recycled Water System (RWS)
- Sunnyvale RWS
- South Bay Water Recycling (SBWR)
- South County Regional Wastewater Authority (SCRWA)

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The Master Plan will identify the volume of water available for potential potable reuse (PR) development and NPR expansion, the optimal allocation between PR and NPR, options for system integration, recommendations for building on NPR projects and creating new PR projects, and proposals for governance model alternatives, including roles and responsibilities. In parallel, Valley Water is developing an updated Water Supply Master Plan (WSMP) that describes its strategy for providing a reliable and sustainable water supply in a cost-effective manner.

The conceptual alternatives evaluation is one of several interim deliverables leading up to the final Master Plan. Building on several earlier technical memoranda (TM)—the Project Definition, Roles, and Responsibilities TM, Regulatory Framework TM, and Baseline Analysis TM—this Conceptual Alternatives TM assesses the County's water reuse market, identifies conceptual project alternatives, and evaluates the alternatives through a prioritization and assessment methodology. The purpose of this deliverable is to select three alternatives that will move forward for feasibility evaluation.

Section 2: Market Assessment

Among other objectives, the Master Plan aims to identify opportunities for PR development and NPR expansion in the county and the optimal split between PR and NPR. To identify, locate, and quantify potential future NPR demand in the county, Valley Water developed a comprehensive NPR market assessment (Attachment A). The market assessment builds on existing planning documents, informs the optimal NPR/PR split, and provides a basis for developing conceptual alternatives to meet future demands.

2.1 Long-term NPR Demands

In preparing the NPR market assessment, Valley Water reviewed the water retailers' most recent recycled water planning documents available and 2015 urban water management plan (UWMP) demand projections, developed by water suppliers in coordination with recycled water producers. The 2015 UWMPs generally contain the most recent demand projections and were used to predict future demands in the Baseline Analysis TM; therefore, they remain the basis for long-term demand projections in this TM.[2] Because UWMPs typically do not explain the assumptions underlying demand projections, it is helpful to review other planning documents for comparison and, where long-term demands differ significantly, further investigate. Details on the retailers' recycled water studies, including target customer areas, recommended pipeline alignments, and differences from the 2015 UWMPs are included in Attachment A. Despite differences for individual cities, total countywide demand projections from the previous sources and 2015 UWMPs are within 2.5 percent of each other. NPR demand projections may be updated as the Master Plan progresses if new information becomes available from the Partner Agencies.

Table 2-1 summarizes total, long-term NPR demands within the Partner Agencies' service areas. These demand projections do not fully capture potential allocations per contractual agreements. For example, the City of Palo Alto is contractually obligated to provide up to 3 million gallons per day (mgd) of recycled water to the City of Mountain View, but projected NPR demands are less than 3 mgd. This analysis assumes future NPR usage aligns with the projections shown in Table 2-1; governance considerations and potential new

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[2] One exception is the City of Morgan Hill (within the SCRWA service area), whose 2015 UWMP projected zero long-term NPR deliveries; however, because an NPR project in Morgan Hill may be feasible in the context of a larger, countywide plan, this TM re-evaluates an NPR system using Morgan Hill's conceptual buildout demands from the 2015 South County Recycled Water Master Plan Update.

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agreements will be further considered when evaluating feasibility. The boundaries of the Partner Agencies' service areas are shown on Figure 2-1.

Table 2-1. Summary of Projected Long-Term NPR Demands by Partner Agency

Partner Agency	Water Retailers	Long-term NPR Demand, mgd (AFY)[a]	Current Contractual Obligation[b]
PA/MV RWS	• City of Palo Alto • City of Mountain View	2.5 (2,800)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	• City of Sunnyvale • Cal Water (Cupertino) • San Jose Water (Cupertino)	1.5 (1,700)	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	• City of Santa Clara • San José Municipal Water System (SJMWS) • San Jose Water • City of Milpitas	21.5 (24,100)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA	• City of Gilroy • City of Morgan Hill	3.3 (3,700) 2.6 (2,900)[c]	N/A
County total		31.5 (35,200)	

a. Projected 2035 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY. For the City of Morgan Hill, NPR demand is equal to the conceptual buildout demand identified in the 2015 South County Recycled Water Master Plan Update. Long-term demands assume that any existing NPR is estimated into the future year UWMP demands, if applicable.

b. Projected NPR demands do not fully capture potential allocations per contractual agreements.

c. Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.

AFY = acre-foot/feet per year

N/A = not applicable

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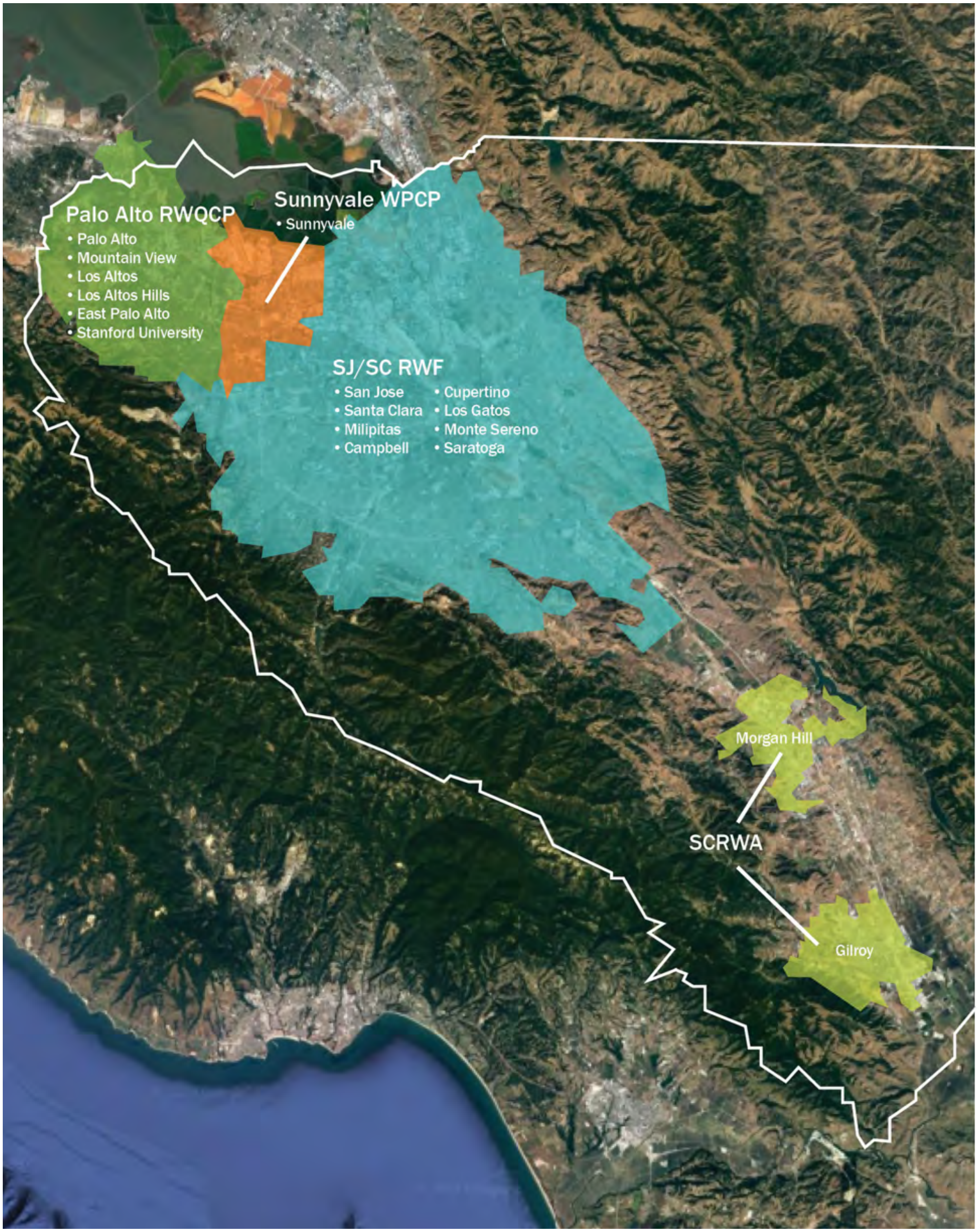

Figure 2-1. Partner Agencies' service area boundaries

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2.2 Identifying the Optimal NPR/PR Split

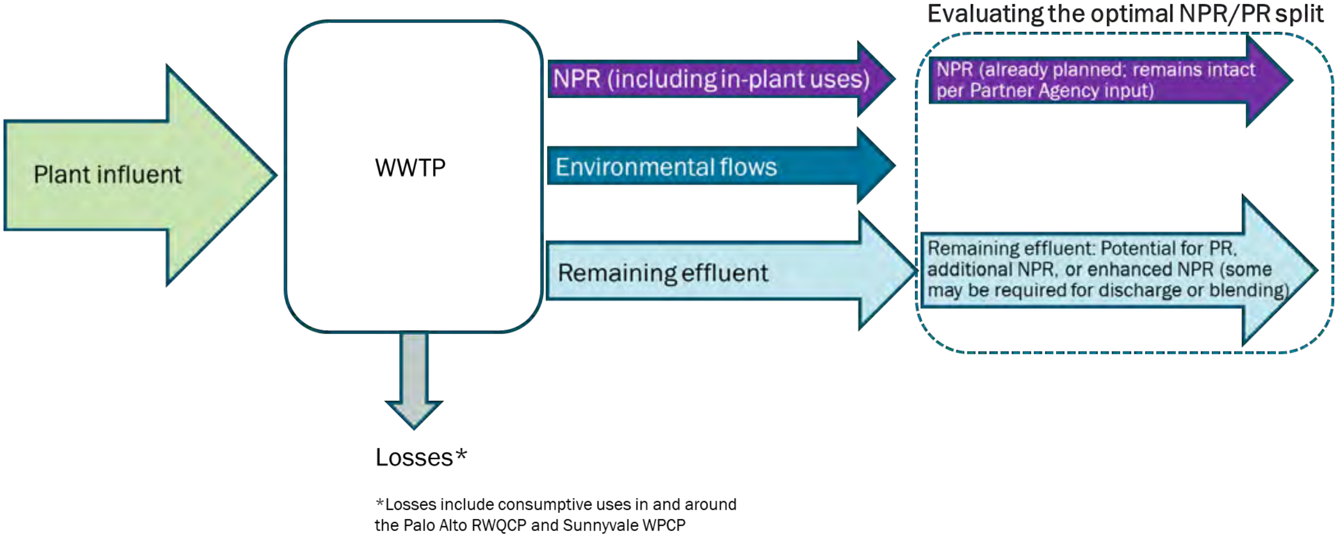
As discussed in the Baseline Analysis TM, the first step in the preliminary evaluation of the optimal NPR/PR split was to identify flows potentially available for additional reuse. These flows were calculated by subtracting the following flow streams from estimated wastewater treatment plant (WWTP) influent:

- 2015 UWMP NPR demand estimates for years 2025 and 2035. These estimates include recycled water usage at the Palo Alto Regional Water Quality Control Plant (RWQCP) and SCRWA WWTP.
- Environmental flows and other losses, such as evaporation. These losses were obtained from public documents or those made available by Partner Agencies.

The NPR market assessment (Attachment A) was completed to inform potential additional NPR opportunities and revise the NPR demand projections, if needed. As discussed in Section 2.1, the results indicate that the market would not support additional NPR beyond the 2015 UWMP estimates; therefore, the 2015 UWMP NPR demand projections were carried forward, except for the City of Morgan Hill, for which conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update were used. NPR demand projections may be updated going forward as new information becomes available from the Partner Agencies.

As described further in Section 4, input regarding potential conceptual alternatives, evaluation criteria, and important project considerations was solicited from project partners and stakeholders during the development of conceptual alternatives. During this process, project partners confirmed the assumption that their projected NPR demands should be kept intact and not made available for other uses. Although the remaining flow could be potentially available as source water for PR, its production may be limited by the capacity of existing treatment and distribution facilities and groundwater recharge (GWR) basins.

These assumptions and considerations, along with the updated market assessment and partner input, have guided the preferred NPR/PR split, as illustrated on Figure 2-2. Based on this process, NPR demands were maintained at the UWMP estimates, and PR solutions were the focus of the remaining effluent (minus any potential requirements for discharge or blending). Enhanced NPR (NPR+), which involves blending purified water with Title 22 recycled water for improved water quality, was also incorporated to allow for interties and improved countywide NPR reliability.


Evaluating the optimal NPR/PR split
Plant influent
WWTP
NPR (including in-plant uses)
Environmental flows
Remaining effluent
NPR (already planned; remains intact per Partner Agency input)
Remaining effluent: Potential for PR, additional NPR, or enhanced NPR (some may be required for discharge or blending)
Losses*

*Losses include consumptive uses in and around the Palo Alto RWQCP and Sunnyvale WPCP

Figure 2-2. Flows considered for NPR/PR split

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Potential project elements and flow balances are discussed in Section 3. The optimal NPR/PR split may be reevaluated, as needed, throughout development of feasible portfolios.

Section 3: Conceptual Alternatives Development

The process used to develop conceptual alternatives for the Master Plan is illustrated on Figure 3-1 and further described in this section. The conceptual alternatives build on existing planning studies completed by various utilities across the county.

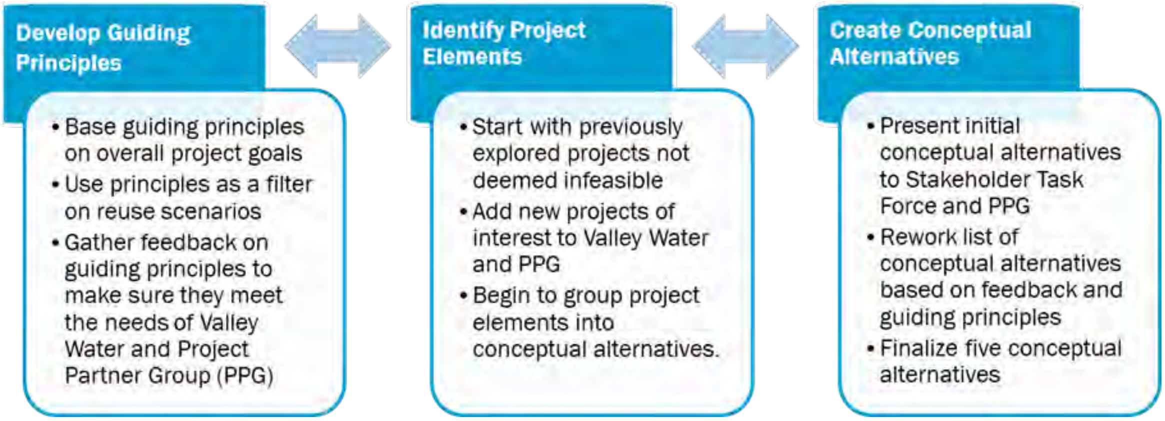
Develop Guiding Principles
• Base guiding principles on overall project goals
• Use principles as a filter on reuse scenarios
• Gather feedback on guiding principles to make sure they meet the needs of Valley Water and Project Partner Group (PPG)
Identify Project Elements
• Start with previously explored projects not deemed infeasible
• Add new projects of interest to Valley Water and PPG
• Begin to group project elements into conceptual alternatives.
Create Conceptual Alternatives
• Present initial conceptual alternatives to Stakeholder Task Force and PPG
• Rework list of conceptual alternatives based on feedback and guiding principles
• Finalize five conceptual alternatives

Figure 3-1. Process used to develop conceptual alternatives

3.1 Process

This section describes the process for developing conceptual alternatives, including the guiding principles applied and basis used.

3.1.1 Guiding Principles

To guide development of alternatives for consideration in this Master Plan, Valley Water identified several guiding principles to provide an early filter on the vast range of possible reuse scenarios. Each alternative must meet the following tenets; these guiding principles support the overall project goal and objectives.

- Consider previously explored projects (not previously deemed infeasible, unless circumstances have changed) and new projects
- Reflect a mix of NPR and PR projects
- Aim to develop at least 24,000 AFY (approximately 21.4 mgd) of PR supply by 2028 to meet the County's water supply demands (per Valley Water's 2019 WSMP 2040)
- Expand countywide reuse (NPR and/or PR) using source water from each of the Partner Agencies
- Leverage existing infrastructure where possible

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3.1.2 Basis for Conceptual Alternatives

Previously explored projects from various recycled water master plans (RWMP) (referred to in Attachment A: Market Assessment) were reviewed to identify the elements that could be combined to align with guiding principles.

During a PPG meeting held June 21, 2018, Valley Water and its Partner Agencies reviewed and discussed an initial set of potential conceptual alternatives. The initial alternatives reflected various thematic combinations of individual projects (elements of each alternative) and were built on a foundation of previously identified projects. Valley Water also identified some new potential projects, including options for developing reuse in Morgan Hill.

Valley Water configured five initial alternatives based on location, proximity, and end use objectives (i.e., NPR and/or PR). To explore the full range of options, two of the five initial alternatives focused on (1) solely expanding NPR and (2) solely developing PR (with continued implementation of currently planned NPR projects). The PPG collectively preferred some mix of both NPR and PR elements. The conceptual alternatives were developed from a mix of identified potential project elements, described in Section 3.2. Based on PPG input, Valley Water developed five conceptual alternatives for screening, as further described in Section 3.3.

3.2 Potential Project Elements

Valley Water identified 17 potential project elements for consideration, as summarized in Table 3-1. Each element is included in at least one conceptual alternative. Project elements and alternatives will be further refined as part of the feasible portfolios evaluation.

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Table 3-1. Preliminary List of Project Elements

No.	Potential Partner(s)	Element	Delivered Water Type	Alternative					Description
				1	2	3	4	5	
1	PA/MV	Palo Alto AWPF	NPR+ or Indirect Potable Reuse (IPR) (via GWR)	✓	✓	✓	✓	✓	Includes a new advanced water purification facility (AWPF) in Palo Alto that is supplied by the RWQCP. Purified water would be sent directly to the Los Gatos Recharge Ponds (LGRP) and/or blended with recycled water for NPR+. Palo Alto is currently planning a 2.25-mgd AWPF (capable of producing a maximum annual volume of ~2,500 AFY) for NPR+. Options involving an AWPF in Palo Alto for IPR would require a larger or separate facility to accommodate both NPR+ and IPR.
2	PA/MV	PA/MV NPR system expansion	NPR+	✓	✓	✓	✓	✓	Includes pumping, storage, and distribution associated with extending service to Stanford Research Park (Palo Alto Phase 3) and the National Aeronautics and Space Administration (NASA)/Whisman School Park alignments, as described in Attachment A. Palo Alto is planning a 2.25-mgd AWPF (capable of producing a maximum annual volume of ~2,500 AFY) to blend purified water with recycled water to supply NPR+ to customers in PA/MV.
3	PA/MV	Palo Alto RWQCP-Sunnyvale AWPF: pipeline	Effluent		✓		✓		Includes wastewater effluent distribution facilities (pumps and pipelines) connecting Palo Alto RWQCP and Sunnyvale Water Pollution Control Plant (WPCP) wastewater effluent to a new, regional AWPF located in either Palo Alto or Sunnyvale.
4	PA/MV	Palo Alto AWPF to LGRP: pipeline	IPR (via GWR)			✓			Includes purified water distribution facilities (pumps and pipeline) connecting a new AWPF in Palo Alto to the LGRP.
5	PA/MV and Sunnyvale	PA/MV-Sunnyvale intertie	NPR+	✓				✓	Includes pipeline crossing Mountain View and Sunnyvale border connecting PA/MV and Sunnyvale NPR systems. Implementation would require similar water quality, most likely NPR+.
6	Sunnyvale and PA/MV	Sunnyvale AWPF or Regional AWPF	NPR+ or IPR	✓	✓	✓	✓	✓	Includes a new AWPF supplied by the Sunnyvale WPCP. Purified water would be blended with recycled water produced at Sunnyvale WPCP. When combined with element #8, AWPF is also supplied by the Palo Alto RWQCP and could be located in either Sunnyvale or Palo Alto.
7	Sunnyvale	Sunnyvale NPR system expansion	NPR+	✓	✓	✓	✓	✓	Involves customer retrofits along recently completed Wolfe Road Main and other infill sites. As mentioned in Attachment A, future expansion could include new pipelines in Sunnyvale as detailed in the Sunnyvale Feasibility Study for Recycled Water Expansion (FSRWE), pending direction from Valley Water regarding countywide recycled water planning.
8	Sunnyvale and PA/MV	Regional AWPF to LGRP: pipeline	IPR		✓		✓		Includes distribution facilities (pumps and pipeline) to convey purified water from a regional AWPF (element #6) to the LGRP.
9	Sunnyvale and SBWR	Sunnyvale-SBWR intertie	NPR+	✓	✓	✓		✓	Includes pipeline crossing Sunnyvale and Santa Clara border connecting Sunnyvale and SBWR systems. Implementation would require NPR+ in Sunnyvale prior to intertie.
10	SBWR	San José/Santa Clara (SJ/SC) AWPF	IPR (via GWR) or Direct Potable Recharge (DPR)	✓				✓	Includes a new AWPF fed by the SJ/SC Regional Wastewater Facility (SJ/SC RWF). Purified water would be delivered to the LGRP (IPR) or Penitencia WTP (DPR, via raw water augmentation), so this element is linked with a distribution project below.

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Table 3-1. Preliminary List of Project Elements

No.	Potential Partner(s)	Element	Delivered Water Type	Alternative 1	2	3	4	5	Description
11	SBWR	SBWR NPR system expansion	NPR+	✓	✓	✓	✓	✓	Includes infill projects in North San José and Santa Clara (including data center cooling and dual plumbing). San Jose Water (SJW) plans to sign up additional customers along existing alignments and construct multiple extensions, while Milpitas seeks to extend the system to the planned Milpitas Transit Area and adjacent golf courses. Any treatment (e.g., Silicon Valley Advanced Water Purification Center [SVAWPC] expansion), pumping, and storage requirements are also included.
12	SBWR	SJ/SC AWPF to LGRP: pipeline	IPR (via GWR)	✓					Includes purified water distribution facilities (pumps and pipeline) connecting the new AWPF to the LGRP.
13	SBWR	SJ/SC AWPF to Penitencia WTP: pipeline	IPR (via GWR)/DPR (via raw water augmentation)	✓				✓	Includes purified water distribution facilities (pumps and pipeline) blending purified water from the SJ/SC AWPF with raw water at Penitencia WTP.
14	SBWR and SCRWA	SBWR-Morgan Hill intertie and Morgan Hill NPR+ system	NPR+	✓	✓				Involves importing recycled water from SBWR to a new NPR+ distribution system in Morgan Hill, including pumps, storage, and distribution system pipelines.
15	SCRWA	Morgan Hill satellite plant and AWPF	IPR (via GWR)			✓	✓	✓	Includes new treatment facilities (satellite plant and AWPF) that would treat wastewater from the sewer trunk line between Morgan Hill and Gilroy and produce purified water for delivery to recharge ponds in South County.
16	SCRWA	Morgan Hill AWPF to South County recharge ponds: pipeline	IPR (via GWR)			✓	✓	✓	Includes purified water distribution facilities (pumps and pipeline) connecting the new AWPF to recharge ponds in South County.
17	SCRWA	Gilroy NPR system expansion	NPR	✓	✓	✓	✓	✓	Includes treatment, pumping, storage, and distribution improvements to improve reliability and extend service within a 10-mile radius of the SCRWA facility.

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Potential NPR elements include expanding the existing NPR system, adding advanced treatment for enhancing recycled water quality (NPR+)[3] and interconnecting distribution networks. NPR+ involves blending purified water (full advanced treatment or equivalent water quality) with Title 22 recycled water for total dissolved solids (TDS) reduction, targeting a maximum TDS of 500 mg/L in the NPR+ system (see Attachment B for more details). 500 mg/L is the drinking water secondary maximum contaminant level for TDS and represents a threshold for protecting groundwater quality when, for example, recycled water is used for irrigation and excess irrigation water percolates into the ground. This higher-quality water would then be delivered to NPR customers using the existing distribution system. Valley Water is assuming full advanced treatment—including associated recovery rates—at all advanced water purification facilities listed below; however, Valley Water is also exploring the feasibility of alternative treatment trains, which may result in increased recovery rates.

Some elements are interdependent. For example, Sunnyvale must reduce TDS prior to interconnecting with the SBWR system, so any alternative proposing a Sunnyvale-SBWR intertie must also include an AWPF in Sunnyvale. Palo Alto is currently planning a 2.25-mgd capacity AWPF (capable of producing a maximum annual volume of approximately 2,500 AFY) for NPR+ (Final Advanced Water Purification System Feasibility, May 2017); thus, an intertie between Sunnyvale and Palo Alto would also require an AWPF in Sunnyvale.

To remain consistent with previous Master Plan work products, this TM uses 2035 recycled water (i.e., NPR) demand projections from 2015 UWMPs, as described in Section 2; however, UWMPs do not necessarily explain the basis for demand projections, which can differ significantly from recycled water plans. For the purpose of this document, future NPR expansion is assumed to occur at locations generally identified within Partner Agencies' recycled water plans up to the annual projections identified in corresponding 2015 UWMPs.

Project elements consider previously explored projects (i.e., not previously deemed infeasible, unless circumstances have changed) and new projects. While most project elements summarized in Table 3-1 have been deemed feasible, one exception is Morgan Hill, whose 2015 UWMP projected zero long-term NPR supply. Although Morgan Hill's 2016 Recycled Water Feasibility Evaluation (RWFE) did not recommend developing an NPR system, an NPR project may be more feasible in the context of a larger, countywide plan. Therefore, Valley Water is further exploring project elements in Morgan Hill as part of this Master Plan, including a connection with SBWR.[4] In addition, Morgan Hill is currently evaluating the potential for a satellite plant to feed an AWPF for GWR, which represents a changed condition from the 2015 South County RWMP Master Plan Update (MPU) and warrants consideration in the countywide context. A satellite plant would divert wastewater from the collection system in Morgan Hill that would otherwise flow to the SCRWA WWTP. Operating scenarios have not been fully developed at this conceptual level, such as operation only during wet or dry years. Ideally a satellite plant, in coordination with equalization and storage, that feeds an AWPF would be sized in a way to allow for continuous AWPF operation. Intermittent operation of an AWPF is not recommended and could negatively impact operation and maintenance.

Because the satellite plant would reduce future planned flows to the SCRWA WWTP, potential impacts to existing plants and flow projections for expanding the SCRWA WWTP must be considered. In addition, an AWPF in Morgan Hill would produce a reverse osmosis (RO) concentrate stream, which may be challenging to manage. A common approach for satellite plants is to discharge brine back to the sewer; however, returning

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[3] Referred to as "Enhanced Recycled Water" in Valley Water's Reverse Osmosis Concentrate Management Plan.

[4] The Silver Creek Agreement with the City of San José entitles Valley Water to a minimum of 5 mgd of recycled water for Valley Water to distribute and/or sell to whomever it wishes, including outside the City of San José tributary agencies

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the brine to SCRWA may not be a feasible option because of salt concentration limits identified in Valley Water's 2014 and 2015 Salt and Nutrient Management plans. Potential reverse osmosis concentrate (ROC) management options have not been fully developed at the conceptual level, but will be further explored as part of the feasible portfolios evaluation.

Potential IPR elements using GWR in the northern portion of the county involve source water from Palo Alto, Sunnyvale, and the (SJ/SC RWF and the production and conveyance of purified water to the LGRP. In the SBWR Strategic and Master Plan (SMP), various PR project alternatives were evaluated for both near-term and long-term implementation. The SBWR SMP identified LGRP as a key component for long-term PR implementation because the recharge ponds are located off-stream and have the largest potential recharge capacity (24,000 AFY) if managed flows are re-operated. Considering existing and projected stream diversion and carry-over imported water operations management, Valley Water determined that this is the only recharge system accessible to North County with the recharge capacity to sustain a major GW replenishment initiative in the Santa Clara Subbasin. As a result, this document has based IPR implementation on using LGRP for GWR.

Potential IPR (via GWR) elements in South County are limited to those involving recharge within the South County area. Although IPR options are described in the 2015 South County Recycled Water Master Plan Update, further study would be needed to determine South County GWR locations. GW subbasins in the county, along with existing recycled water facilities, are shown on Figure 3-2.

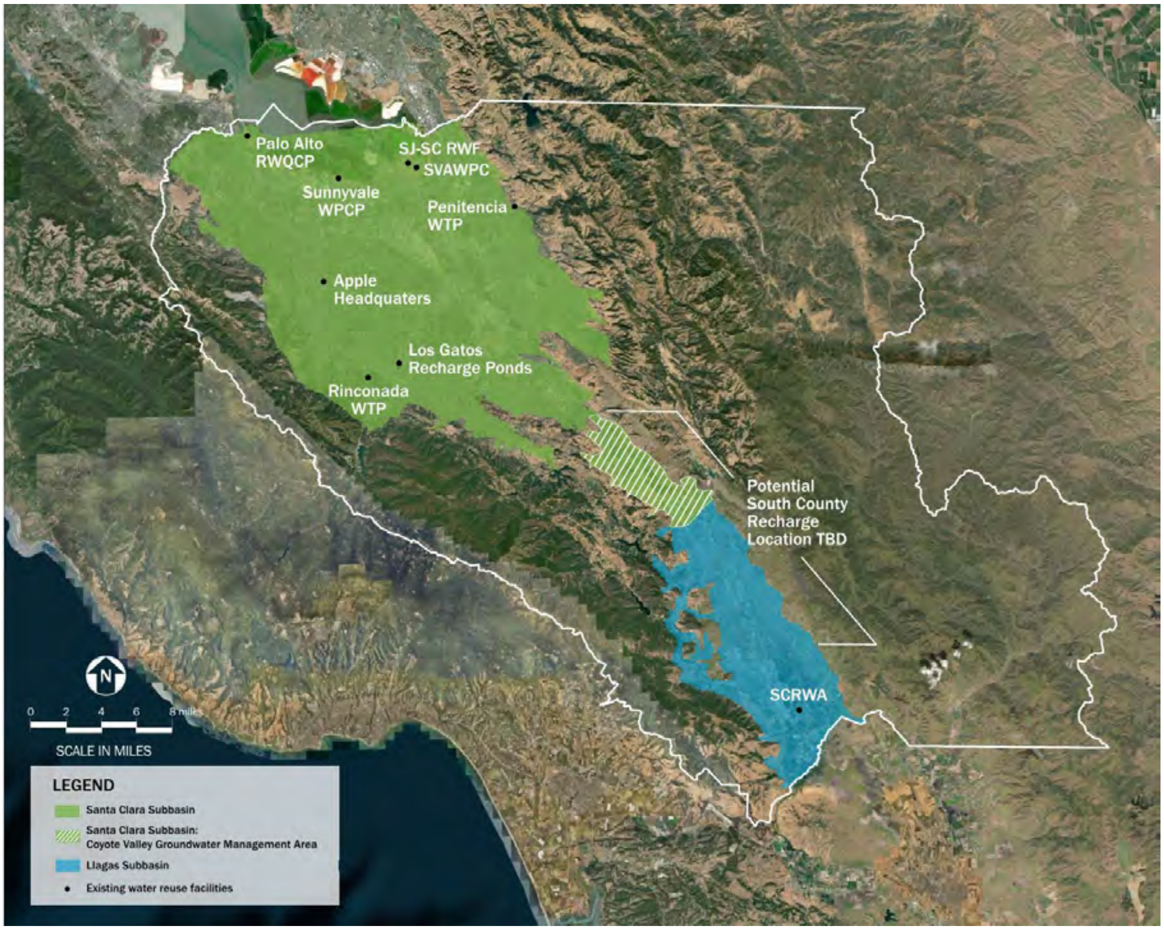

Figure 3-2. GW subbasins and recharge facilities related to IPR elements of conceptual alternatives

Potential DPR elements in the conceptual alternatives involve raw water augmentation. Though California does not yet have a regulatory framework for raw water augmentation, the state is developing such regulations by 2023. The DPR scenario considered in the conceptual alternatives involves constructing a new AWPF near the SJ/SC RWF and a new conveyance pipe to deliver purified water to the Central Pipeline. From the Central Pipeline, purified water would be blended with raw (untreated) water from the South Bay Aqueduct before flowing to either the Penitencia Water Treatment Plant (WTP) or Rinconada WTP for conventional treatment. Raw water augmentation was not considered in South County as it would not be as directly beneficial as IPR via GWR. Though treated water augmentation was not considered in the conceptual alternatives, future treated water augmentation opportunities will be explored as part of the feasibility evaluation.

3.2.1 Intertie Opportunities

Interties that connect existing recycled water distribution systems will increase NPR system flexibility, reliability, and potentially the quantity of source water available from a specific producer. By sizing interties and constructing storage tanks to allow the receiving agency to supplement its NPR demand with the use of imported recycled water, “local” effluent becomes available for other purposes. Using recycled water from multiple sources can also improve diurnal supply reliability, particularly for systems that have higher peak hour NPR demands. This more diversified supply portfolio frees Partner Agencies to explore NPR expansion opportunities while also maximizing the utilization rate of countywide reuse efforts.

Though no demands or quantities of recycled water flowing through interties are shown in the following sections, this will be detailed as part of subsequent efforts of this Master Plan. Specifically, the feasible portfolios analysis will detail the use, location, size, and quantity of recycled water transported by interties. As a default scenario, the interties will allow for the transport of recycled water among the Partner Agencies such that Valley Water can plan PR and NPR elements detailed herein with a level of confidence that they can supply that quantity of water during most types of years. Where required, adding storage tanks, pump stations, pressure sustaining valves, and pressure zones to convey recycled water between distribution systems while maintaining pressure within each system will be evaluated.

Interties between NPR systems were also planned assuming that all interconnected systems would have similar TDS concentrations. Thus, if one NPR distribution system had NPR+, any system interconnected to it would also have NPR+ in any evaluated alternative.

3.3 Conceptual Alternatives

Valley Water combined the 17 potential project elements introduced in Section 3.2 into five conceptual alternatives. Elements common to all five alternatives are listed below:

- **Elements 1 and 6:** Constructing new AWPFs in Palo Alto and Sunnyvale.
- **Elements 2, 7, 11, and 17:** Expanding existing NPR systems (PA/MV, Sunnyvale, SBWR, and SCRWA) to deliver enough recycled water to meet the 2035 recycled water demands outlined in each water retailer’s 2015 UWMP. Further, elements 2, 7, and 11 include improving recycled water quality in North County NPR systems (PA/MV RWS, Sunnyvale RWS, and SBWR) for NPR+.

In the following subsections, each alternative is described further in terms of major project elements, a flow balance, and pros and cons relative to other alternatives. Each is illustrated as a graphic depicting proposed project elements on a countywide scale. The graphics show existing facilities as gray. New advanced treatment facilities are color-coded based on function; purple AWPFs augment NPR systems, and blue AWPFs supply IPR and DPR projects. Figure 3-3 reflects the existing/baseline conditions.

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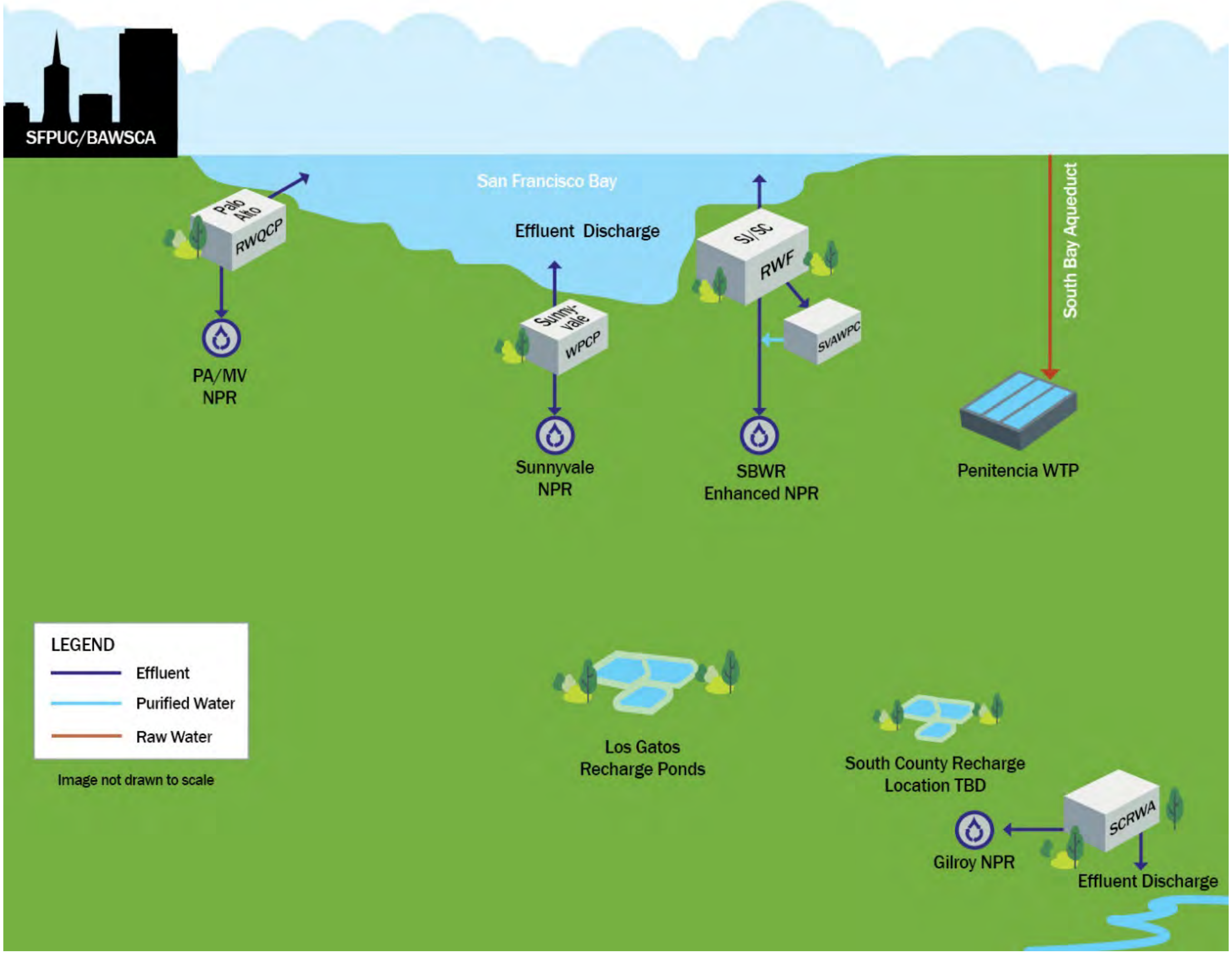

Figure 3-3. Existing facilities related to conceptual alternatives.

Pros and cons that apply to all alternatives are summarized in Table 3-2. ROC management options for the alternatives will be further detailed in the ROC Management Plan, a parallel but separate effort from this Master Plan. Similarly, the benefits of reduced nutrient loading to San Francisco Bay and Monterey Bay are addressed in other studies and not evaluated in this TM.

Table 3-2. Pros and Cons of All Alternatives

Pros	Cons
• Reduced discharge to San Francisco Bay/ Monterey Bay • NPR+ across entire North County (PA/MV RWS, Sunnyvale RWS, and SBWR) • Interties (especially bi-directional) increase reliability and operational flexibility • Decreased dependence on imported water • Local supplies offsetting imports could reduce GHG overall	• RO concentrate management challenging • Interties will require new agreements • Environmental impacts of construction

Note: This is not an exhaustive list. Some criteria, such as cost, greenhouse (GHG) gas emissions, or other, may appear as a pro or a con, depending on the alternative.

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The conceptual alternatives are not defined at the level of detail needed to estimate utilization, which depends on a number of factors, including:

- Local groundwater conditions
- Water system operations (e.g., flow balancing)
- Recovery rates and ROC management options
- Local water rights and source priorities
- Water demands

Actual utilization rates and how the rates may vary temporally will be considered in the feasible portfolios evaluation.

Flow balances are based on the projected 2035 effluent availability analysis presented in the Baseline Analysis TM, which accounts for losses, potential environmental flows, and NPR demand. However, where new AWPFs are considered for NPR+, recovery rates of microfiltration (MF) and RO increase the amount of flow required to meet NPR demands. Though SBWR already delivers NPR+, the available effluent estimated in the baseline analysis did not factor in blending for SJ/SC RWF for simplicity. Per Valley Water's ROC Management Plan Basis of Design TM, MF and RO are assumed to be 93 and 85 percent efficient, respectively. In other words, while 1.00 unit of effluent could produce 1.00 unit of tertiary recycled water, it takes approximately 1.27 units (1/0.93/0.85) of effluent to produce 1.00 unit of purified water.

All four Partner Agencies have an NPR+ multiplier of approximately 1.1, as described further in Attachment B. That is, for every 1,000 AFY of NPR demand, approximately 1,100 AFY of effluent is needed to produce 1,000 AFY of NPR+. Flow balances presented in the following subsections account for improved NPR water quality at the Palo Alto RWQCP, Sunnyvale WPCP, and SJ/SC RWF. Since NPR+ was not considered in the 2015 South County Recycled Water MPU, the alternatives do not contemplate changing the water quality of NPR produced at the SCRWA WWTP, so an adjustment is not necessary for that flow.

The volume of available purified water was calculated by applying advanced treatment (MF/RO) recovery rates to available effluent (influent less NPR demand, losses, and potential environmental flows). These values, rounded to the nearest 100 AFY, are provided in Table 3-3 for 2035. A range of estimated losses is shown for PA/MV and Sunnyvale to reflect varying assumptions. To be conservative, the higher losses (resulting in less available purified water) were carried forward in the conceptual alternatives analysis. Flow assumptions may be further refined as more recent data and/or projections become available.

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Table 3-3. Preliminary Estimate of Supply Available for Purified Water in 2035

Partner Agency	Available Influent (AFY)[a]	Influent Required to Produce and Meet NPR+ Demands (AFY)[b]	Losses/Potential Environmental Flows (AFY)	Available Effluent/AWPF Feed (AFY)[c]	Available Purified Water (AFY)
Palo Alto RWQCP	24,700	3,100	1,500–3,700[d]	17,900–20,100	14,100–15,900
Sunnyvale WPCP	19,400	1,900	1,600–4,500[e]	13,000–15,900	10,300–12,600
SJ/SC RWF • With Morgan Hill NPR+ • Without Morgan Hill NPR+	 120,200 120,200	 29,400[f] 26,300	 0 0	 90,800 93,900	 71,800 74,300
SCRWA Service Area • Potential Morgan Hill AWPF and Satellite Plant	3,600[g]	N/A	0	3,600	2,800
Countywide Total[h]	167,900	31,300-34,400	3,000-8,200	125,300-133,600	99,000-105,600

a. *Estimated based on 2015-2017 actuals and projected rate of increase from previous planning studies, as further described in the Baseline Analysis TM.*

b. *NPR demands do not necessarily include contractual obligations. For this analysis, it was assumed that NPR demands will increase per 2015 UWMP projections, and any remaining effluent (after accounting for losses, potential environmental flows, and the supply required to produce and meet NPR+ demands) would be available for AWPF feed. New agreements, however, may be needed to access this full amount for countywide use.*

c. *Assumes that all remaining effluent is available as feed water for an AWPF; blending or discharge requirements will be further considered as the Master Plan progresses, along with potential new contractual agreements.*

d. *Flow to Renzel Marsh, ranging from 1 mgd (~1,100 AFY; current amount reflected in National Pollutant Discharge Elimination System [NPDES] permit) to 3 mgd (~3,400 AFY; future potential expansion), along with an estimated 0.3 mgd (~300 AFY) loss of effluent used for in-plant processes (per Palo Alto's 2015 UWMP).*

e. *Low end of range reflects actual evaporation from 2015–16, which was 1.4 mgd on average (1,600 AFY); high end of range assumes 4 mgd (4,500 AFY) of evaporative and other losses.*

f. *The additional influent requirement of 3,100 AFY is the product of the NPR demand identified in the 2015 South County RWMP Update (2,900 AFY for conceptual buildout in Morgan Hill) and the SJ/SC RWF "NPR+ multiplier."*

g. *Assumes 3.2 mgd (3,600 AFY) will be diverted from the existing trunk sewer to produce purified water in Morgan Hill. No project elements were identified that involved SCRWA WWTP as the AWPF feed source.*

h. *Difference due to rounding.*

Some project elements that interconnect systems may affect the volume of supply available for other purposes. For example, if SBWR supplies Morgan Hill's new NPR+ system, more SJ/SC RWF effluent would be needed to produce additional recycled water and purified water for blending. The SCRWA WWTP and proposed Morgan Hill satellite plant are similarly related, as any wastewater diverted in Morgan Hill would reduce available influent to the SCRWA WWTP. Based on the baseline analysis, an average of 3.2 mgd (approximately 3,600 AFY) of effluent is available from the SCRWA WWTP during 2035. According to the 2010 Relief Trunk Capacity Allocation study developed by the City of Morgan Hill, future average dry weather flow (ADWF) in the trunk sewer from Morgan Hill was estimated at 5.2 mgd (approximately 5,800 AFY), so there is sufficient flow to divert the entire available volume (3.2 mgd, or 3,600 AFY) to produce purified water in Morgan Hill. Using the aforementioned advanced treatment recovery rates, this translates to approximately 2,800 AFY of purified water. When NPR demand in the Gilroy area exceeds available effluent from the SCRWA WWTP, this deficit could be supplied by groundwater wells. The satellite plant element was chosen in lieu of adding an AWPF at SCRWA because it eliminates the need to convey flow to a SCRWA AWPF for treatment and then back to Morgan Hill for distribution.

The preliminary PR flow balance was completed by allocating the available purified water to each recharge pond or WTP that would receive PR per the conceptual alternative. Table 3-4 summarizes the capacities for the LGRP, South County recharge ponds (using Church Recharge Ponds as a proxy), and Penitencia WTP. For the recharge ponds, capacities represent the maximum annual volume the ponds can accept. Penitencia WTP capacity is based on delivery to a new 3-million-gallon (MG) storage tank near the treatment plant. Flow balance figures for each alternative focus on the allocation of purified water for NPR+ and PR, because the assumed NPR and losses/environmental flows are the same across all alternatives. The color scheme is similar to the figures showing major elements of each alternative: gray facilities are existing, purple facilities produce purified water for NPR+, and blue facilities supply purified water for PR.

Table 3-4. Capacities of Recharge Ponds and WTP to Potentially Receive Purified Water for PR

Receiving Facility	Reuse Type	Annual Capacity (AFY)	Source
Los Gatos Recharge Ponds	IPR (via GWR)	24,000	Valley Water Expedited Purified Water Program Plan
Penitencia WTP	DPR (via raw water augmentation)	26,900[a]	Valley Water Expedited Purified Water Program Plan
South County recharge ponds[b]	IPR (via GWR)	7,300	Morgan Hill 2016 RWFE

a. *Based on 24 mgd (26,900 AFY) delivery to new 3-MG purified water tank near Penitencia WTP.*

b. *Specific location in South County to be decided in feasible alternatives. The annual capacity of Church Recharge Ponds is currently referenced as a proxy.*

3.3.1 Alternative 1: IPR via GWR (from SJ/SC) and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 1.

3.3.1.1 Major Project Elements

Alternative 1 combines expanded and interconnected NPR+ systems with IPR supply from the SJ/SC RWF. New AWPFs would be located in Palo Alto (as currently planned) and Sunnyvale for NPR+ (elements 1 and 6), allowing for connection to the SBWR system (elements 5 and 9) and NPR+ deliveries (elements 2, 7, and 11). In addition, a new NPR system in Morgan Hill would be supplied by SBWR (element 14), so NPR+ systems would be interconnected among all three North County systems and Morgan Hill in South County. An expanded Gilroy system (element 17) would remain separate and maintain its current NPR water quality.

A new AWPF would also be constructed in San José to produce purified water from SJ/SC RWF effluent (element 10), along with new distribution facilities to transport purified water from the new AWPF to the LGRP (element 12). Figure 3-4 illustrates the major elements of Alternative 1.

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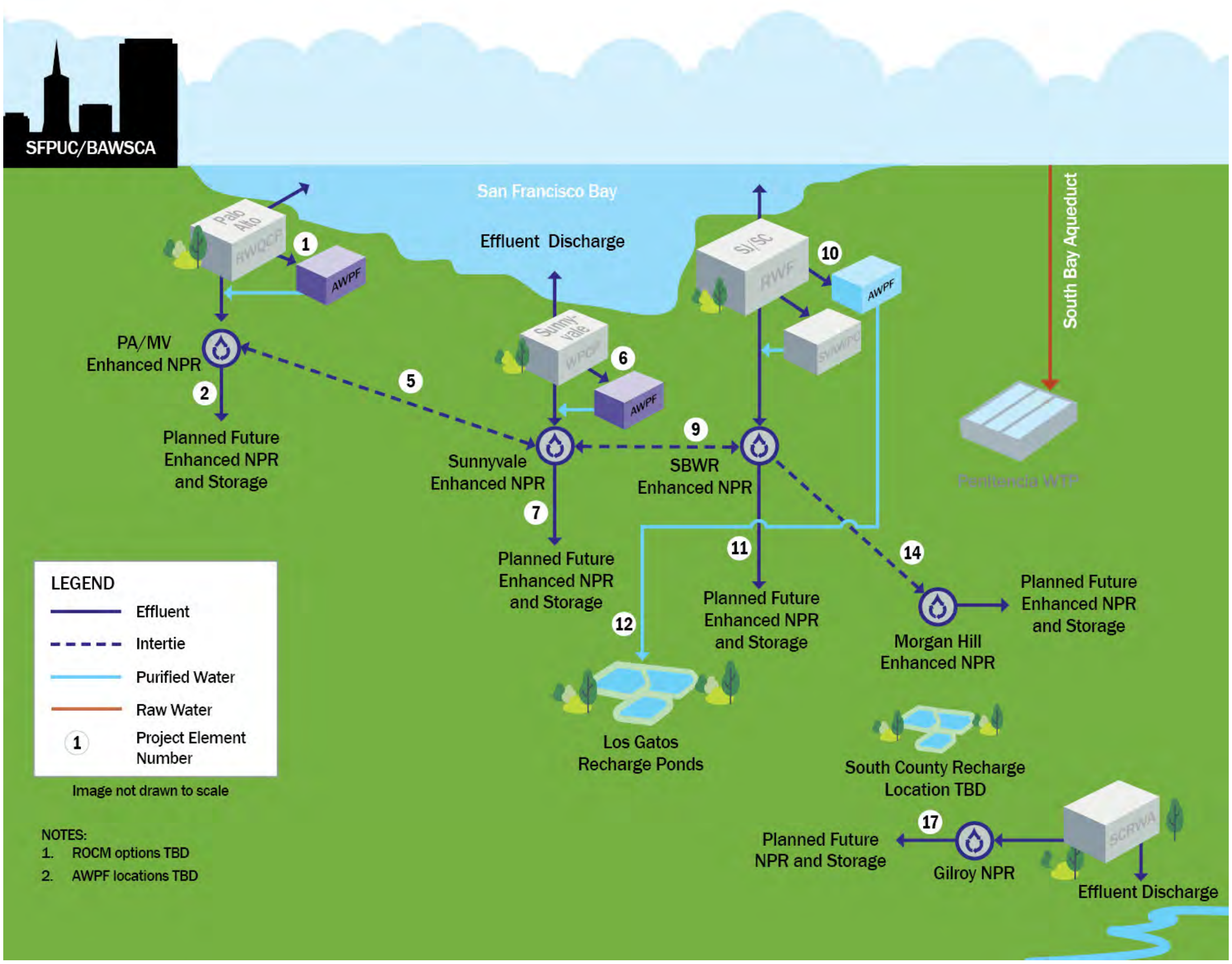

NOTES:
1. ROCM options TBD
2. AWPF locations TBD

Figure 3-4. Alternative 1 elements

3.3.1.2 Flow Balance

The SJ/SC facilities (Silicon Valley Advanced Water Purification Center [SVAWPC] and new AWPF) would be capable of providing sufficient volume to supply both the LGRP and Morgan Hill's new NPR+ system. After accounting for Morgan Hill NPR+ demands, available effluent from the SJ/SC RWF translates to approximately 71,800 AFY of available purified water. With 24,000 AFY going to the LGRP, approximately 47,800 AFY remains available for system reliability and flexibility, including future water reuse expansion considerations. Figure 3-5 illustrates the purified water flows for Alternative 1.

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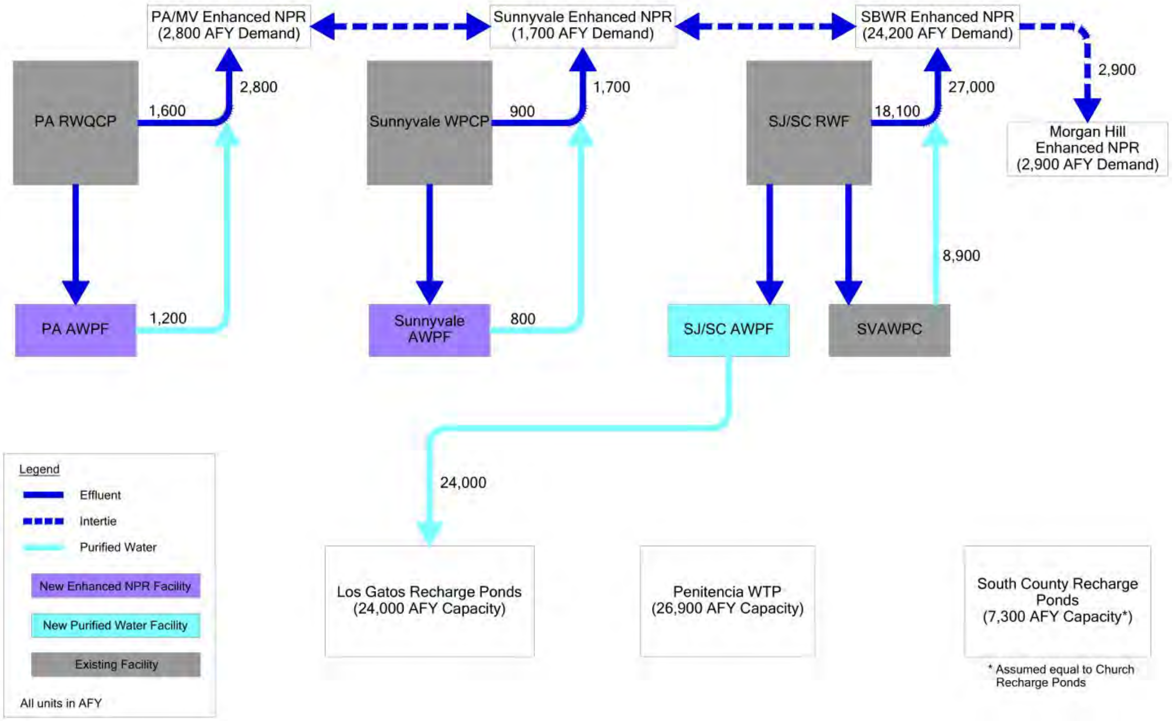
PA/MV Enhanced NPR (2,800 AFY Demand)
Sunnyvale Enhanced NPR (1,700 AFY Demand)
SBWR Enhanced NPR (24,200 AFY Demand)
2,900
Morgan Hill Enhanced NPR (2,900 AFY Demand)
PA RWQCP
1,600
2,800
Sunnyvale WPCP
900
1,700
SJ/SC RWF
18,100
27,000
8,900
PA AWPF
1,200
Sunnyvale AWPF
800
SJ/SC AWPF
SVAWPC
24,000
Los Gatos Recharge Ponds (24,000 AFY Capacity)
Penitencia WTP (26,900 AFY Capacity)
South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds
Legend
Effluent
Intertie
Purified Water
New Enhanced NPR Facility
New Purified Water Facility
Existing Facility
All units in AFY

Figure 3-5. Alternative 1 purified water flow balance

3.3.1.3 Pros and Cons

Alternative 1 features extensive improvements (one AWPF for IPR via GWR, two AWPFs for NPR+, and North County NPR+ interties), which increase supply reliability and operational flexibility and enhance NPR water quality. In addition, having separate AWPFs allows implementation to proceed independently without having to wait for permitting or agreements from potential partners.

Connecting a new Morgan Hill NPR system to SBWR would utilize the Silver Creek Pipeline (SCP), which extends from Silver Creek Valley Road to the Metcalf Energy Center at the southern tip of the SBWR system. Valley Water cost-shared in oversizing the SCP in exchange for the right to use a minimum of 5 mgd (5,600 AFY) from it. This use agreement between Valley Water and the City of San José expires in 2027. Securing long-term supply to Morgan Hill would require a new or updated agreement. This is consistent with other interties, which will also require agreements. Lastly, with almost 100 feet of elevation gain, pumping recycled water from SBWR to Morgan Hill will require significant amounts of energy. Table 3-5 highlights the pros and cons of Alternative 1 relative to other conceptual alternatives.

Table 3-5. Pros and Cons of Alternative 1

Pros	Cons
• Increased reliability throughout county from NPR+ interties • Augments GW supply from single facility and agency experienced in GWR • Separate AWPFs allow for streamlining implementation • Known treatment technologies	• Capital and operation and maintenance (O&M) costs related to 3 new AWPFs (34,900 AFY combined purified water capacity), 3 interties, and new Morgan Hill NPR+ distribution system • Significant pumping and pipe requirements for SBWR-Morgan Hill connection • Agreements required for multiple interties • SCP agreement may expire

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3.3.2 Alternative 2: IPR via GWR (from Palo Alto/Sunnyvale) and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 2.

3.3.2.1 Major Project Elements

Alternative 2 features expanded and interconnected NPR+ systems in North County, similar to Alternative 1 except IPR supply would come from a Sunnyvale AWPF instead of one located in San José. A new, regional AWPF in Sunnyvale would take effluent from both the Palo Alto RWQCP and the Sunnyvale WPCP (elements 3 and 6) and supply purified water to the LGRP (element 8). In addition, the AWPF would allow for NPR+ deliveries in Sunnyvale (element 7) and the SBWR service area (element 11). A new AWPF in Palo Alto for NPR+ deliveries (elements 1 and 2) would allow the North County NPR+ systems to be interconnected (elements 5 and 9).

South County elements (14 and 17) are identical to Alternative 1. Figure 3-6 illustrates the major elements of Alternative 2.

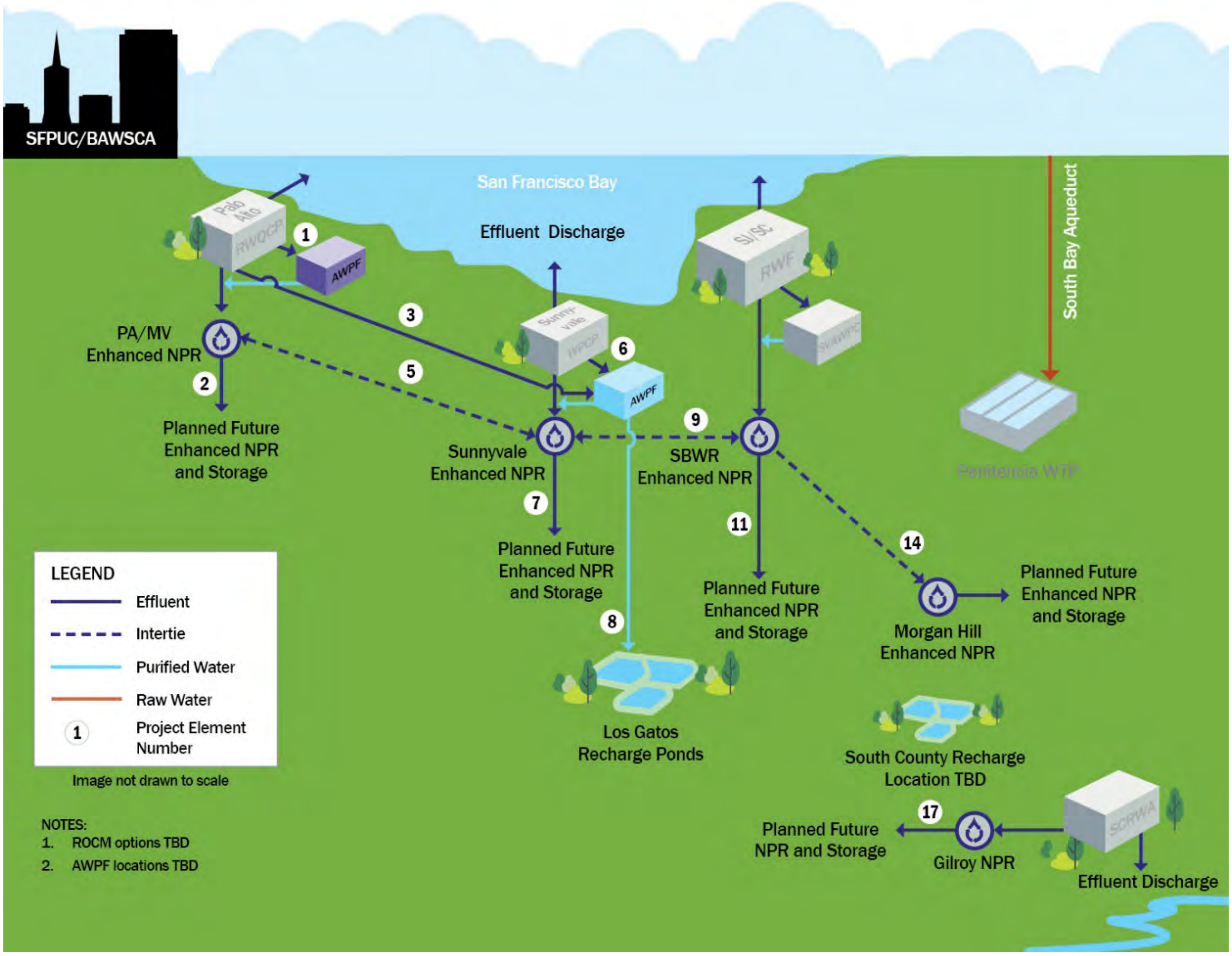

Figure 3-6. Alternative 2 elements

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3.3.2.2 Flow Balance

Based on long-term projections, approximately 14,100 AFY of purified water would be available from the Palo Alto RWQCP, and the Sunnyvale WPCP could add approximately 10,300 AFY, for a total of 24,400 AFY. While this is just above the LGRP capacity of 24,000 AFY, the surplus was assumed to be negligible. See Figure 3-7 for a schematic of purified water flows.

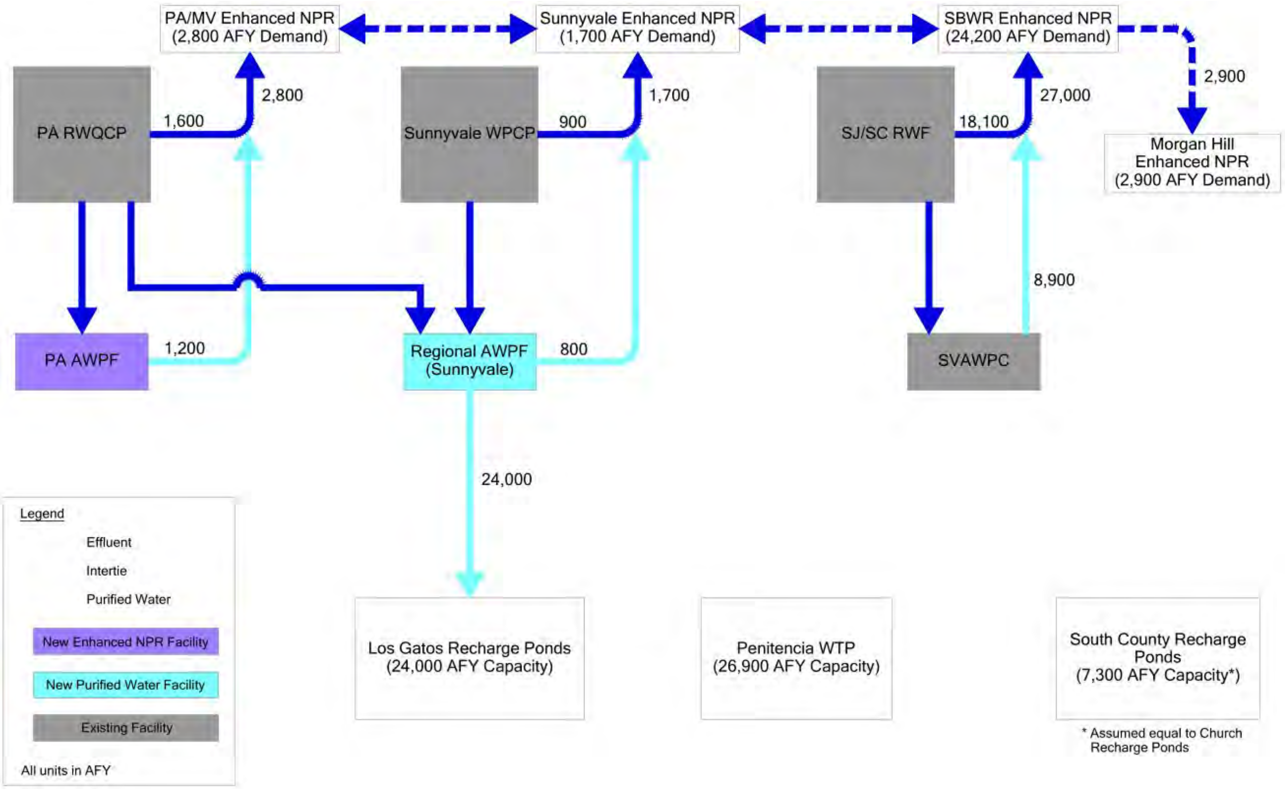
PA/MV Enhanced NPR (2,800 AFY Demand)
Sunnyvale Enhanced NPR (1,700 AFY Demand)
SBWR Enhanced NPR (24,200 AFY Demand)
2,900
Morgan Hill Enhanced NPR (2,900 AFY Demand)
PA RWQCP
1,600
2,800
Sunnyvale WPCP
900
1,700
SJ/SC RWF
18,100
27,000
8,900
PA AWPF
1,200
Regional AWPF (Sunnyvale)
800
SVAWPC
24,000
Legend
Effluent
Intertie
Purified Water
New Enhanced NPR Facility
New Purified Water Facility
Existing Facility
All units in AFY
Los Gatos Recharge Ponds (24,000 AFY Capacity)
Penitencia WTP (26,900 AFY Capacity)
South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds

Figure 3-7. Alternative 2 purified water flow balance

3.3.2.3 Pros and Cons

By sending Palo Alto effluent to Sunnyvale for advanced treatment, permitting becomes more complex, as the regional AWPF in Sunnyvale would receive effluent from two sources. In addition, the City of Sunnyvale has relatively limited experience with IPR via GWR. On the other hand, taking effluent from a second Partner Agency would improve AWPF feed reliability. NPR+ reliability would also improve as a result of interties throughout North County.

Because Alternative 2 also proposes supplying Morgan Hill's NPR system via an intertie with SBWR, the same SCP challenge introduced in Alternative 1 would apply. Table 3-6 highlights the pros and cons of Alternative 2 relative to other conceptual alternatives.

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Table 3-6. Pros and Cons of Alternative 2

Pros	Cons
• Increased reliability throughout county from NPR+ interties • Augments GW supply from regional AWPF (served by Palo Alto RWQCP and Sunnyvale WPCP), which has greater feed reliability than an AWPF served by Sunnyvale WPCP alone • Known treatment technologies	• Capital and O&M costs related to 2 new APWFs (34,900 AFY combined purified water capacity), 3 interties, and new Morgan Hill NPR+ distribution system • Regional AWPF in Sunnyvale complicates permitting • Regional AWPF limits feed to Palo Alto AWPF, which could limit NPR expansion in PA/MV and Sunnyvale • Significant pumping and pipe requirements for SBWR-Morgan Hill connection • Requires two separate transmission pipelines between PA/MV and Sunnyvale for AWPF influent and NPR+ • Agreements required for multiple interties • SCP agreement may expire • Limited agency experience in PR

3.3.3 Alternative 3: IPR via GWR (from Palo Alto and Morgan Hill) and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 3.

3.3.3.1 Major Project Elements

Alternative 3 shifts the IPR supply from the Palo Alto RWQCP, which would feed a new AWPF in Palo Alto (element 1). Purified water would be delivered to the NPR+ system for blending (element 2) and the LGRP via a new pipeline (element 4). In contrast to Alternatives 1 and 2, the PA/MV NPR+ system would remain separate from Sunnyvale. A new AWPF in Sunnyvale (element 6) would improve NPR water quality, allowing for connection to SBWR (element 9) and expansion of both systems (elements 7 and 11).

Instead of an NPR+ system in Morgan Hill, Alternative 3 favors IPR via GWR in South County. New treatment and purification facilities would divert wastewater on its way to the SCRWA WWTP (element 15) for treatment and delivery to the selected recharge location in South County (element 16). As in Alternatives 1 and 2, an expanded Gilroy system (element 17) would remain separate and maintain its current NPR water quality. Figure 3-8 illustrates the major elements of Alternative 3.

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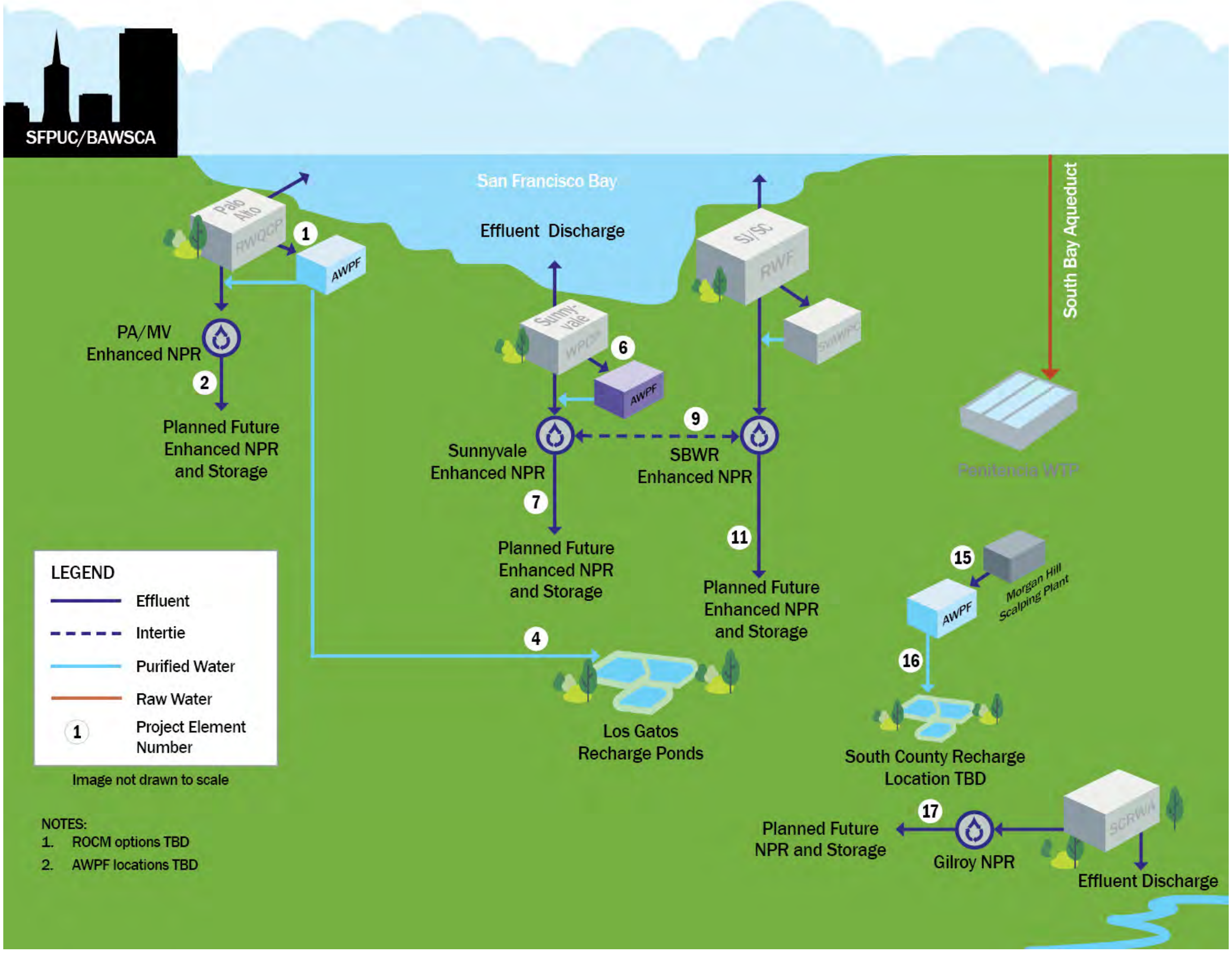

Figure 3-8. Alternative 3 elements

3.3.3.2 Flow Balance

With only approximately 14,100 AFY in available purified water, the Palo Alto RWQCP (and AWPF) cannot produce sufficient volume to meet the LGRP recharge capacity (24,000 AFY). Similarly, diverting and treating wastewater in Morgan Hill yields a modest amount (approximately 2,800 AFY). These elements are shown on Figure 3-9.

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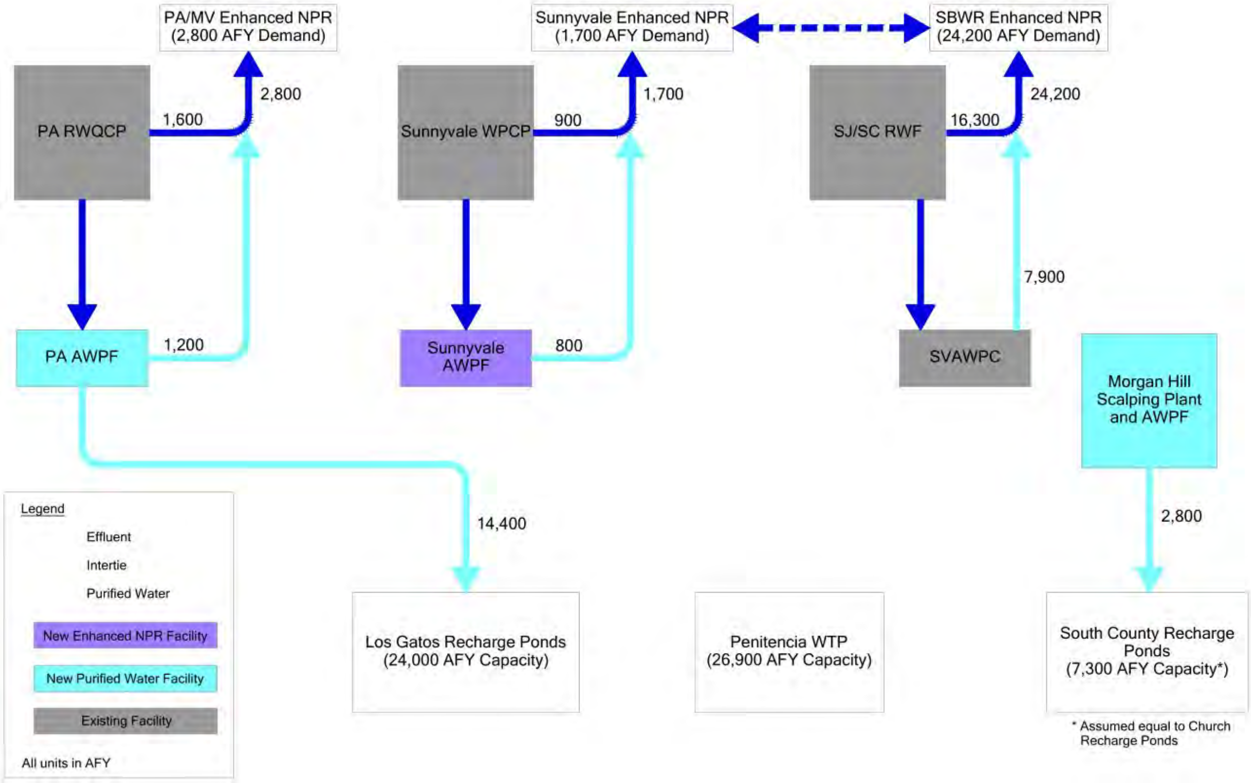
PA/MV Enhanced NPR (2,800 AFY Demand)
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SBWR Enhanced NPR (24,200 AFY Demand)
PA RWQCP
1,600
2,800
Sunnyvale WPCP
900
1,700
SJ/SC RWF
16,300
24,200
7,900
PA AWPF
1,200
Sunnyvale AWPF
800
SVAWPC
Morgan Hill Scalping Plant and AWPF
14,400
2,800
Legend
Effluent
Intertie
Purified Water
New Enhanced NPR Facility
New Purified Water Facility
Existing Facility
All units in AFY
Los Gatos Recharge Ponds (24,000 AFY Capacity)
Penitencia WTP (26,900 AFY Capacity)
South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds

Figure 3-9. Alternative 3 purified water flow balance

3.3.3.3 Pros and Cons

While Alternative 3 improves reliability across the Sunnyvale and SBWR systems, the PA/MV NPR system remains separate. With LGRP supply from Palo Alto, supplies are limited. Palo Alto would not be able to produce enough purified water to meet LGRP capacity, even if some of the flow was not reserved for NPR blending. At the same time, Palo Alto is farther from the LGRP than SJ/SC and Sunnyvale facilities, so conveyance for this alternative would cost more in comparison. Lastly, it is assumed that this alternative would require a larger AWPF in Palo Alto than the currently planned 2.25-mgd facility. Given the high cost of land in the area, this is a significant economic impact.

In South County, reduced flows to the SCRWA WWTP could have multiple effects, and the net impact remains unclear. While a new trunk sewer between Morgan Hill and the SCRWA WWTP could be delayed or possibly downsized, other capital improvements may be required. Odor and clogging issues in the collection system could arise if wastewater velocities are too low to scour the pipes and re-suspend solids. Further, biological processes at the WWTP could be compromised by changes in influent wastewater composition. According to the City of Morgan Hill's 2016 RWFE, intermittent sludge wasting at the satellite plant could hinder biological treatment at the WWTP to the point that solids processing would be required at the WWTP, increasing capital and operational costs. Sludge loading and reduced flow to the WWTP could also create compliance issues. Table 3-7 highlights the pros and cons of Alternative 3 relative to other conceptual alternatives.

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Table 3-7. Pros and Cons of Alternative 3

Pros	Cons
• Increased reliability for Sunnyvale and SBWR • Augments GW in North and South Counties, each from a single facility • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP • Separate AWPFs allow for streamlining implementation • Known treatment technologies	• Capital and O&M costs related to 3 new APWFs (26,900 AFY combined purified water capacity, including Morgan Hill) and 1 intertie • Greater distance between Palo Alto and LGRP than SJ/SC and Sunnyvale facilities • Less water to LGRP than Alternatives 1 and 2 • Larger AWPF in Palo Alto requires more land than other alternatives • PA/MV system remains separate, limiting NPR expansion in PA/MV • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Morgan Hill AWPF RO concentrate management feasibility has not been fully evaluated • Diverting flow during higher demand periods could require supplemental water supply (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations • Limited agency experience in IPR via GWR

3.3.4 Alternative 4: IPR via GWR (from Palo Alto/Sunnyvale and Morgan Hill) and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 4.

3.3.4.1 Major Project Elements

Alternative 4 favors IPR via GWR over system interties. A new AWPF in Palo Alto would produce purified water for blending (elements 1 and 2), while a regional AWPF in Sunnyvale would take effluent from both the RWQCP and WPCP for NPR blending and delivery to the LGRP (elements 3, 6, 7, and 8). The PA/MV and Sunnyvale NPR+ systems would be connected (element 5), but SBWR would remain separate (element 11). As in Alternative 3, Morgan Hill would divert and treat wastewater before purifying effluent for GWR (elements 15 and 16). As in Alternatives 1, 2, and 3, an expanded Gilroy system (element 17) would remain separate and maintain its current NPR water quality. Figure 3-10 illustrates the major elements of Alternative 4.

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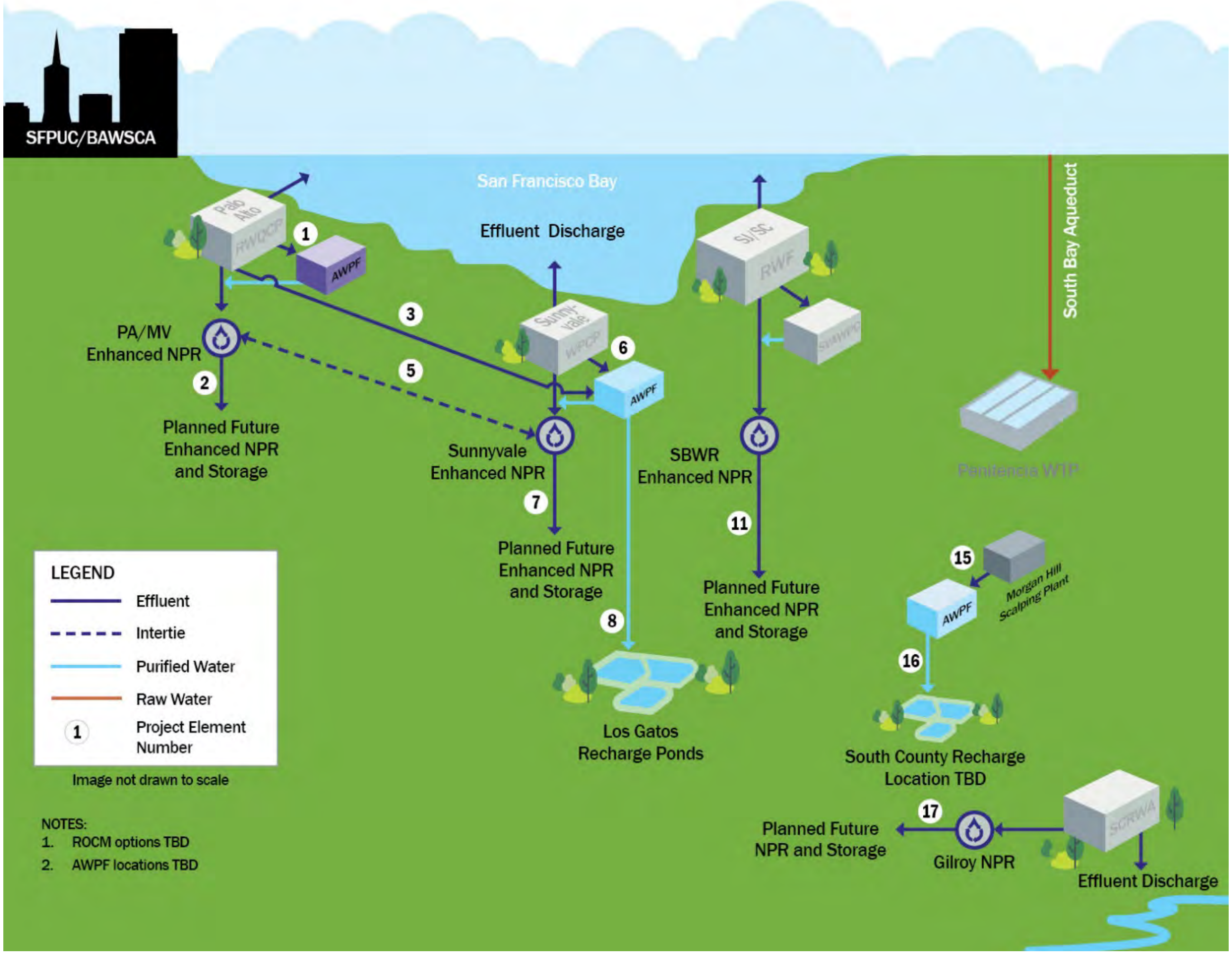

Figure 3-10. Alternative 4 elements

3.3.4.2 Flow Balance

The regional AWPF in Sunnyvale would be able to produce approximately 24,400 AFY of purified water to deliver to the LGRP. As discussed in Section 3.3.2.2, the 400 AFY surplus was assumed to be negligible. Diverting and treating wastewater in Morgan Hill would generate 2,800 AFY of purified water, less than 40 percent of the assumed capacity of the South County recharge ponds. Figure 3-11 shows the Alternative 4 flows.

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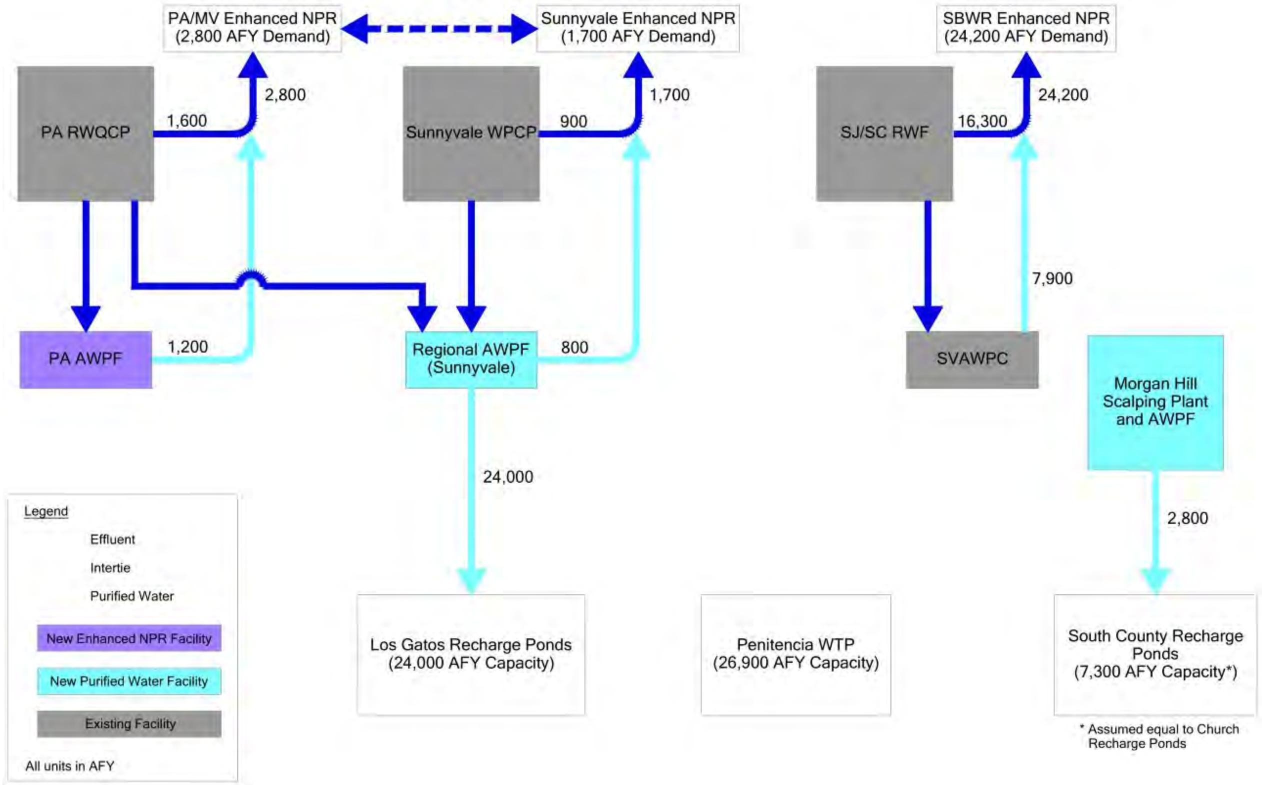
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SJ/SC RWF
16,300
24,200
7,900
PA AWPF
1,200
Regional AWPF (Sunnyvale)
800
SVAWPC
Morgan Hill Scalping Plant and AWPF
24,000
2,800
Legend
Effluent
Intertie
Purified Water
New Enhanced NPR Facility
New Purified Water Facility
Existing Facility
All units in AFY
Los Gatos Recharge Ponds (24,000 AFY Capacity)
Penitencia WTP (26,900 AFY Capacity)
South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds

Figure 3-11. Alternative 4 purified water flow balance

3.3.4.3 Pros and Cons

As Alternative 4 proposes the same regional AWPF in Sunnyvale as Alternative 2, its potential benefits (feed reliability) and challenges (more complicated permitting, reduced supply for future NPR expansion, and limited agency experience with IPR via GWR) also carry over. The main differences are that SBWR remains separate, and Morgan Hill would implement IPR via GWR instead of NPR+. Table 3-8 highlights the pros and cons of Alternative 4 relative to other conceptual alternatives.

Table 3-8. Pros and Cons of Alternative 4

Pros	Cons
• Increased reliability for PA/MV and Sunnyvale from NPR+ intertie • Augments GW supply from regional AWPF (fed by Palo Alto RWQCP and Sunnyvale WPCP), which has greater feed reliability than an AWPF fed by Sunnyvale WPCP alone • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP • Known treatment technologies	• Capital and O&M costs related to 3 new AWPF (36,700 AFY combined purified water capacity, including Morgan Hill) and 1 intertie • Regional AWPF in Sunnyvale complicates permitting • Regional AWPF limits feed to Palo Alto AWPF, which could limit NPR expansion in PA/MV and Sunnyvale • SBWR remains separate, limiting NPR expansion in San José • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Morgan Hill AWPF RO concentrate management feasibility has not been fully evaluated • Diverting flow during higher demand periods could require supplemental water supply (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations • Limited agency experience in IPR via GWR

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3.3.5 Alternative 5: IPR via GWR (from Morgan Hill), DPR via raw water augmentation (from SJ/SC), and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 5.

3.3.5.1 Major Project Elements

Alternative 5 is similar to Alternative 1 in North County, with new AWPFs in Palo Alto and Sunnyvale for NPR+ (elements 1 and 6), allowing for connection to the SBWR system (elements 5 and 9) and NPR+ deliveries (elements 2, 7, and 11). A new AWPF would also be constructed in San José to produce purified water from SJ/SC RWF effluent (element 10); however, instead of sending purified water to the LGRP, the new SJ/SC AWPF would augment raw water at the Penitencia WTP (element 13). Similar to Alternatives 3 and 4 in South County, Morgan Hill would implement IPR via GWR (elements 15 and 16). As in Alternatives 1, 2, 3 and 4, an expanded Gilroy system (element 17) would remain separate and maintain its current NPR water quality. Figure 3-12 illustrates the major elements Alternative 5.

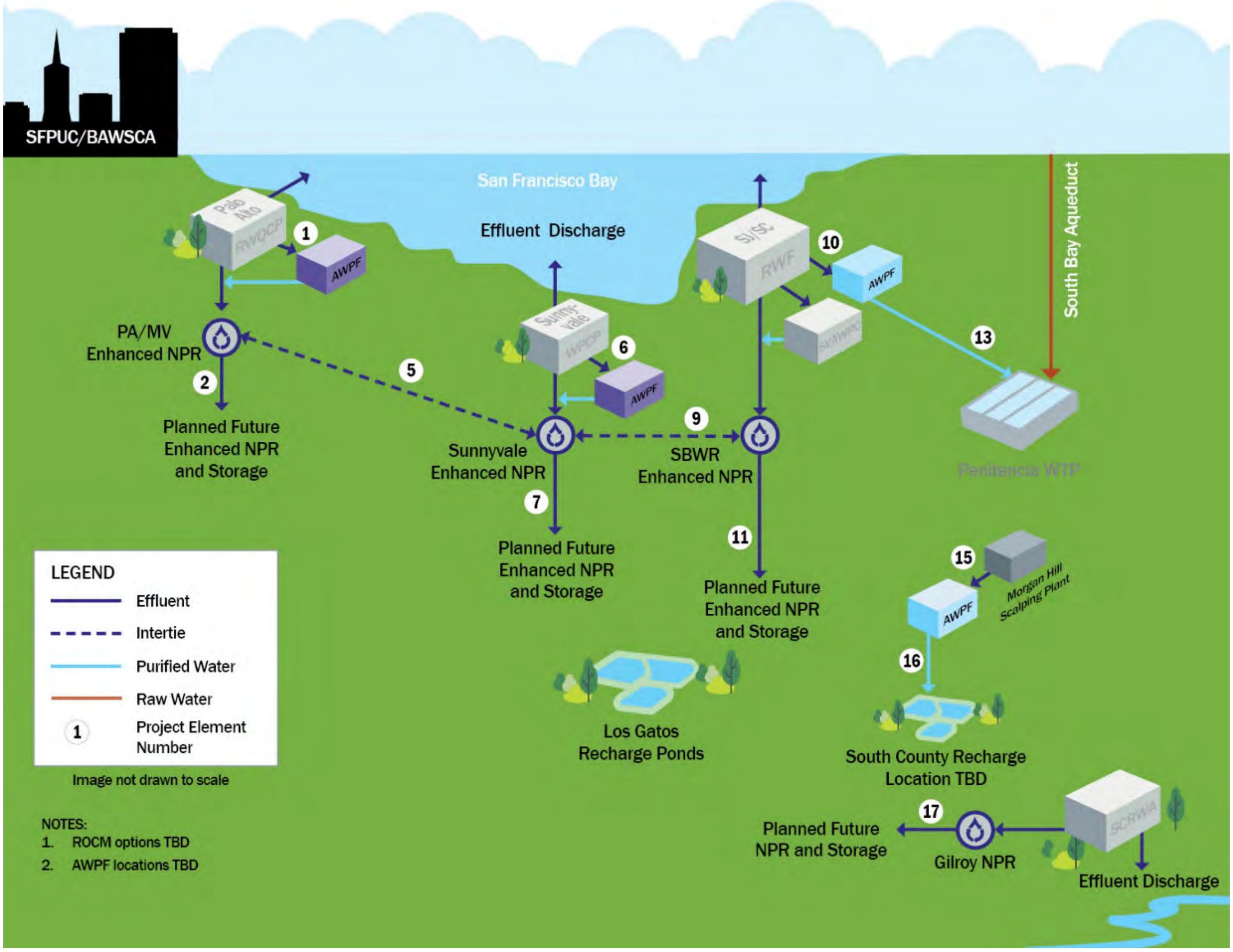

Figure 3-12. Alternative 5 elements

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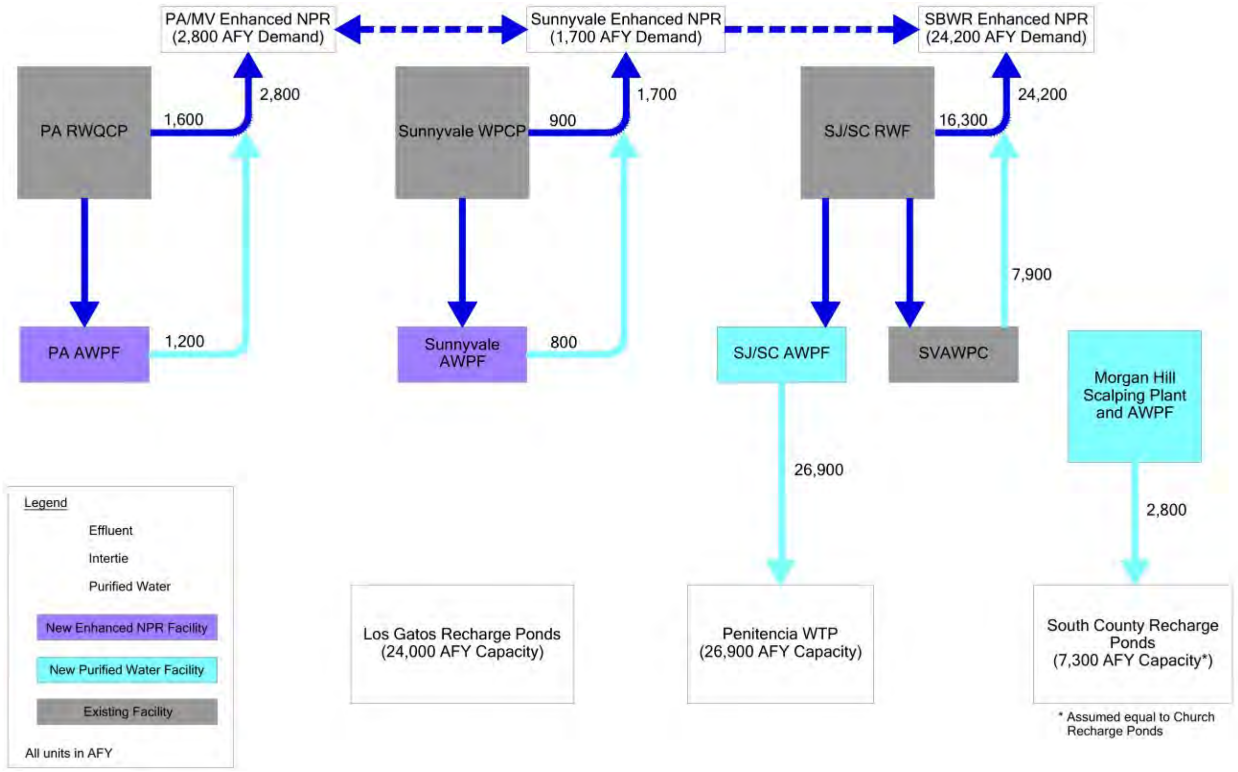
3.3.5.2 Flow Balance

The SJ/SC RWF can supply sufficient effluent volume to deliver the full 26,900 AFY of purified water to the Penitencia WTP. As with Alternatives 3 and 4, a modest volume of approximately 2,800 AFY of purified water is available for GWR in South County. These elements are shown on Figure 3-13.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Penitencia WTP (26,900 AFY Capacity)
South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds

Figure 3-13. Alternative 5 purified water flow balance

3.3.5.3 Pros and Cons

Alternative 5 shares the NPR benefits of Alternative 1—increased reliability and recycled water quality. Although potable water reliability improves with raw water augmentation at the Penitencia WTP, substituting DPR for IPR via GWR is a risk when regulations are still in progress. Ultimately, implementing DPR may require additional facility improvements, especially related to treatment, monitoring, and operations. These additional improvements, combined with relatively high purified water production capacity, would further increase costs beyond those of other alternatives. Table 3-9 highlights the pros and cons of Alternative 5 relative to other conceptual alternatives.

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Table 3-9. Pros and Cons of Alternative 5

Pros	Cons
• Increased reliability in North County from NPR+ interties • Greater reliability for potable water than the other alternatives • Augments GW from single facility and agency experienced in GWR • Separate AWPFs allow for streamlining implementation • Treating wastewater flow in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP	• Capital and O&M costs related to 4 new AWPFs (39,600 AFY combined purified water capacity, including Morgan Hill) and 2 interties • Costly improvements for DPR and purified water production capacity and monitoring (highest of all alternatives) • DPR regulations are not yet established • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Morgan Hill AWPF RO concentrate management feasibility has not been fully evaluated • Unknown additional technologies for achieving DPR level of treatment • Diverting flow in Morgan Hill during higher NPR demand periods could require supplemental water supply in Gilroy area (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations

3.3.6 Summary

Table 3-10 compares purified water flows among alternatives, rounded to the nearest 100 AFY. Because NPR+ deliveries are equal between alternatives, the table focuses on combined flows for PR (LGRP, Penitencia WTP, and South County recharge ponds). Available purified water from SJ/SC RWF effluent depends on whether Morgan Hill develops an NPR+ system (Alternatives 1 and 2); thus, these cases are treated separately.

Table 3-10. Purified Water Available for PR Alternatives

Supply Source	Source Water Available for PR, Considering Treatment Losses[a] (AFY)	Purified Water Provided for PR (AFY)[b]				
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Palo Alto RWQCP	14,100[c]	0	14,000	14,100	14,000	0
Sunnyvale WPCP	10,300[c]	0	10,000	0	10,000	0
SJ/SC RWF						
• With Morgan Hill NPR+ [d]	71,800[e]	24,000	0	N/A	N/A	N/A
• Without Morgan Hill NPR+	74,300[e]	N/A	N/A	0	0	26,900
SCRWA Service Area • Potential Future Morgan Hill AWPF and Satellite Plant	2,800	0	0	2,800[f]	2,800[f]	2,800[f]
County total						
• With Morgan Hill NPR+ [d]	99,000	24,000	24,000	17,000[g]	26,800	29,700
• Without Morgan Hill NPR+	101,500	24,000	24,000	17,000[g]	26,800	29,700
PR locations		LGRP	LGRP	LGRP, South County recharge ponds	LGRP, South County recharge ponds	Penitencia WTP, South County recharge ponds

a. Assumes that all remaining effluent is available as feed water for an AWPF; blending or discharge requirements will be further considered as the Master Plan progresses, along with potential new contractual agreements. Treatment losses account for advanced treatment recovery rates.

b. Purified water provided is limited to recharge capacity or treatment capacity of receiving facility.

c. Based on high estimates of future losses and potential environmental flows.

d. Alternatives 1 and 2 include Morgan Hill NPR+. Alternatives 3, 4, and 5 do not.

e. Per the assumptions in the Baseline Analysis TM, no potential environmental flows were considered for SJ/SC RWF.

f. Delivered to recharge ponds in South County; exact location TBD.

g. Difference due to rounding.

N/A = not applicable.

Alternative 5 delivers the most purified water for PR, a result of the higher capacity at the Penitencia WTP relative to the LGRP. Alternative 3 delivers the least because Palo Alto alone cannot meet the LGRP capacity.

Source water flow projections—and consequently, projected purified water production—may be refined as new information (e.g., updated NPR demand projections) becomes available.

Section 4: Process for Prioritization and Assessment

This section describes the approach to prioritizing and assessing conceptual alternatives.

4.1 Methodology

The process for prioritization and assessment begins with selecting criteria and identifying the respective weight of each criterion (weighting factor) to apply when evaluating alternatives. Assessing alternatives through the lens of each criterion helps to illuminate their relative strengths and weaknesses.

Valley Water developed initial criteria considering objectives of the Master Plan and typical criteria of funding opportunities with the U.S. Bureau of Reclamation (Reclamation) and the Department of Water Resources (DWR) with the goal of striking a balance across these considerations. Table 4-1 illustrates the relationship between the Master Plan objectives and typical criteria of Reclamation and DWR funding opportunities.

Table 4-1. Objectives Considered When Developing Criteria

Theme	Countywide Master Plan Objectives	Reclamation Funding	DWR Funding
Increase water reuse supply	Determine reuse supply availability and benefits. Identify sources and amounts of water available for reuse; the appropriate split between NPR and PR; and regional, Valley Water, and local-level benefits from NPR and PR.	• Increase water supplies and reduce demand on non-recycled water supplies.	--
Promote regional solutions	Evaluate potential regional integration. Facilitate innovative approaches and collaboration for residuals management, permitting, and land use decisions. Optimize use of supply and infrastructure, improve system reliability and flexibility, and explore redefining sewersheds.	• Address water supply sustainability. • Promote a watershed perspective/integrated resources management. • Improve habitat and water quality.	• Consider Integrated Regional Water Management Plan implementation (regionalism, partnerships, and integration). • Address multiple goals. • Reduce dependence on the Delta.
Governance and economics	Guide system expansion through interagency agreements and governance. Analyze the economics of project alternatives and explore cost-sharing opportunities.	• Complete authorized Title XVI projects. • Implement cost-effective projects. • Meet legal and contractual water supply obligations.	• Integrate multiple resource management strategies. • Optimize project costs and financing. • Demonstrate technical and economic feasibility.
Social issues/public acceptance	Generate regional support for the Master Plan via coordination and outreach. Improve public perception of water reuse through outreach programs.	• Provide benefits to rural or economically disadvantaged communities (DAC).	• Provide benefits to DAC and Native American tribal community water issues. • Consider environmental justice.
Readiness to proceed	--	• Promote projects that are ready to proceed.	• Promote projects that are ready to proceed.
Climate change	--	• Incorporate use of renewable energy and promote energy efficiency.	• Incorporate climate change adaptation, including reduction in GHG emissions.

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Valley Water aligned objectives based on common themes, aggregated them into initial prioritization criteria, and assigned initial weighting factors by criterion. Assigning weighting factors to criteria helps reflect the values and preferences of stakeholders and decision makers when assessing and prioritizing project alternatives. Consistent with standard decision-making approaches, weighting factors varied by criterion.

4.2 Criteria and Weighting

During a PPG meeting held June 21, 2018, Partner Agencies provided input to Valley Water on the initial criteria and weighting factors. Based on Partner Agencies' feedback, Valley Water refined and confirmed prioritization criteria and respective weighting, as summarized in Table 4-2.

Table 4-2. Prioritization Criteria and Weighting

Criterion	Notes	Weighting
Economics	Including capital and O&M costs and rate/customer affordability impacts	25%
Groundwater management and countywide (regional) supply reliability	Including groundwater protection (quality and quantity) and dry year/drought resilience benefits	25%
Environmental impacts/benefits and sustainability	Including environmental impacts/benefits, energy use, and GHG production	20%
Ease of implementation and permitting/regulatory considerations	Including governance/partnership, public acceptance, permitting/compliance, environmental and social justice, timing (readiness to proceed), and staff resource considerations	15%
Engineering feasibility	Including water quality (source and product water), monitoring requirements, and treatment technology	15%
	Total	100%

4.3 Ranking

The conceptual alternatives identified in Section 3 were evaluated relative to each criterion listed in Table 4-2. Each alternative was awarded a score between 1 and 5 based on how well it satisfies each individual criterion, as described further in Section 5. The alternatives' relative rankings were used to identify three alternatives to be carried forward to feasibility-level assessment.

Section 5: Outcomes of Alternatives Ranking and Selection

This section presents the outcomes of the alternatives ranking and selection process.

5.1 Conceptual Alternatives Evaluation

Each conceptual alternative was scored initially by the project team and refined with input from Valley Water and the PPG. Scores were applied using the scale summarized in Table 5-1 and with respect to the considerations listed below.

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Table 5-1. Scale for Scoring Conceptual Alternatives

Score	Evaluation Criteria				
	Economics	GW Management and Countywide (Regional Supply Reliability)	Environmental Impacts/Benefits and Sustainability	Ease of Implementation and Permitting/Regulatory Considerations	Engineering Feasibility
5	$	Highest volume for potable reuse; interties for supply reliability	Positive environmental benefit	Reuse regulations in place. Experienced with operational requirements. Few or no agreements required.	Permitted and proven on respective water reuse application. Short pipelines through developed areas.
4	$$	High volume for potable reuse; interties for supply reliability	Neutral benefit/impact	Reuse regulations in development. Some experience with technology and operational requirements. Few agreements required.	Permitted and proven on drinking water; demonstrated but not yet permitted for respective potable reuse applications.
3	$$$	Sufficient volume for potable reuse; some interties for supply reliability	Minimal environmental concerns	Reuse regulatory framework and timeline in place. Limited experience with technology and operational requirements. Some agreements required.	Treatment approach in demonstration-scale (further commitment over pilot).
2	$$$$	Low volume for potable reuse; few interties for supply reliability	Moderate impacts requiring mitigation	Reuse regulatory framework anticipated. No experience with technology and operational requirements. Multiple agreements required.	Treatment approach in pilot-scale.
1	$$$$$	Lowest volume for potable reuse; few/no interties for supply reliability	Significant environmental impacts	No regulations in place or on horizon. No experience with operational requirements. Many agreements required.	Concept or research-based treatment technology. Complex/unfamiliar operational requirements. Long pipelines through urban, developed areas.

Economics. New advanced treatment facilities, distribution systems, and pipelines add capital and O&M costs. Costs will be fleshed out in the feasible portfolios evaluation, along with effects on water rates and local economy. For the purpose of this assessment, conceptual alternatives are scored relative to one another. Alternatives that incorporated extensive new infrastructure scored lower in this category than alternatives that leveraged existing facilities and had fewer new facilities.

GW Management and Countywide (Regional) Supply Reliability. Per the guiding principles, alternatives should incorporate a mix of NPR and PR and add volume for PR. Alternatives that added a larger volume for PR were scored higher in this category than alternatives with less volume committed to PR. For this evaluation, it is assumed that all alternatives will incorporate requirements to maintain GW quality protection; thus, this is not a differentiator among alternatives.

Environmental Impacts/Benefits and Sustainability. The potential impacts of an alternative on the environment (positive or negative) include energy consumption, quantity and quality of flows to receiving water bodies, and ease of adaptation to changes in physical or statutory conditions (e.g., climate change, catastrophic events, population or economic growth, regulatory changes). Lower scores were applied to alternatives with multiple AWPFs that have higher energy requirements for RO, resulting in higher GHG production, and to those that may adversely affect existing environmental conditions of receiving water bodies.

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Ease of Implementation and Permitting/Regulatory Considerations. This criterion weighs the potential effects (positive or negative) of an alternative on the local community, specifically DACs, and the acceptability of the measure to customers/ratepayers and local interest groups. Alternatives that have known reuse permitting pathways and environmental documentation requirements were scored higher than those with more complex requirements or regulations that are new or still in development. Lower scores were given to alternatives that had longer project implementation timelines or more complex staffing/operational requirements.

Engineering Feasibility. The alternatives generally involve similar project components in terms of equipment, technology, and water quality goals; however, their scales (i.e., capacity, length, and number of facilities) vary. Alternatives including the Morgan Hill satellite plant and AWPF received a lower score because of the additional unit processes needed for primary and secondary treatment of wastewater. Long pipelines through heavily congested areas can be challenging during construction, as reflected in lower scores in this area.

The scoring for each alternative is summarized in Table 5-2.

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Table 5-2. Conceptual Alternatives' Scores

			Conceptual Alternative 1		Conceptual Alternative 2		Conceptual Alternative 3		Conceptual Alternative 4		Conceptual Alternative 5	
Criterion	Notes	Weighting	Score	Scoring Reasoning	Score	Scoring Reasoning	Score	Scoring Reasoning	Score	Scoring Reasoning	Score	Scoring Reasoning
Economics	Including capital and O&M costs and rate/customer affordability impacts	25%	3.0	Capital and O&M costs related to: 3 new AWPFs with combined purified water capacity of 34,900 AFY (24,000 AFY for PR and 10,900 AFY for NPR+); 3 intertie pipes; and new Morgan Hill NPR+ distribution system	3.0	Capital and O&M costs related to: 2 new AWPFs with combined purified water capacity of 34,900 AFY (24,000 AFY for PR and 10,900 AFY for NPR+); 3 intertie pipes; and new Morgan Hill NPR+ distribution system	2.0	Capital and O&M costs related to: 3 new AWPFs with combined purified water capacity of 26,900 AFY (17,000 AFY for PR and 9,900 AFY for NPR+); 1 intertie pipe; new pipe from Palo Alto to Los Gatos; limited land availability in Palo Alto; and new Morgan Hill satellite plant and AWPF	3.0	Capital and O&M costs related to: 3 new AWPFs with combined purified water capacity of 36,700 AFY (26,800 AFY for PR and 9,900 AFY for NPR+); 1 intertie pipe; new Morgan Hill satellite plant and AWPF	1.0	Capital and O&M costs related to: 4 new AWPFs with combined purified water capacity of 39,600 AFY (29,700 AFY for PR and 9,900 AFY for NPR+); DPR treatment/monitoring; 2 intertie pipes; new Morgan Hill satellite plant and AWPF
GW management and countywide (regional) supply reliability	Including GW protection (quality and quantity) and dry year/drought resilience benefits	25%	3.0	Augments GW supply from SJ/SC (large volume); interties provide drought resilience	3.0	Augments GW supply (combined volume) from Sunnyvale and Palo Alto; interties provide drought resilience	2.0	Augments GW supply from Palo Alto, though with less water than other alternatives; intertie provides drought resilience	4.0	Augments GW supply (combined volume) from Sunnyvale & Palo Alto; intertie between Sunnyvale and Palo Alto provides drought resilience; no intertie with SBWR	5.0	Augments surface water from SJ/SC; reoperation would direct more imported water to recharge due to DPR; interties provide drought resilience
Environmental impacts/benefits and sustainability	Including environmental impacts/benefits, energy use, and GHG production	20%	4.0	3 new, separate AWPFs for NPR+ and IPR; local supplies could offset increased imports, reducing GHG overall for water deliveries	4.0	2 new, separate AWPFs for NPR+ and IPR; local supplies could offset increased imports, reducing GHG overall for water deliveries	3.0	3 new, separate AWPFs for NPR+ and IPR; local supplies could offset increased imports, reducing GHG overall for water deliveries	4.0	3 new, separate AWPFs for NPR+ and IPR; local supplies could offset increased imports, reducing GHG overall for water deliveries	2.0	4 new, separate AWPFs for NPR+ and DPR; local supplies could offset increased imports, reducing GHG overall for water deliveries
Ease of implementation and permitting/regulatory considerations[a]	Including governance/partnership, public acceptance, permitting/compliance, environmental and social justice, timing (readiness to proceed), and staff resource considerations	15%	5.0	SCP agreement may expire; agency experienced in GWR and using a single facility	4.0	SCP agreement may expire; limited or no agency experience in PR	2.0	New Morgan Hill satellite plant and AWPF may require extensive permitting; limited land availability in Palo Alto	3.0	New Morgan Hill satellite plant and AWPF may require extensive permitting	1.0	DPR regulations anticipated in 2023; DPR has no precedent in California; new Morgan Hill satellite plant and AWPF may require extensive permitting
Engineering feasibility	Including water quality (source and product water), monitoring requirements, and treatment technology	15%	4.0	Known technologies for achieving level of treatment; pipeline(s) through developed urban areas	4.0	Known technologies for achieving level of treatment; pipeline(s) through developed urban areas	3.0	Known technologies for achieving level of treatment; however, adding new Morgan Hill satellite plant and AWPF may present staffing/ resource challenges	3.0	Known technologies for achieving level of treatment; however, adding new Morgan Hill satellite plant and AWPF may present staffing/ resource challenges	1.0	Unknown additional technologies for achieving DPR-level of treatment; new Morgan Hill satellite plant and AWPF may present staffing/resource challenges
	Total	100%	3.7		3.5		2.4		3.5		2.2	

a. Permitting and regulatory considerations are discussed in more detail in the Regulatory Compliance Strategy.

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5.2 Feasible Alternatives Selection

Based on the results of the scoring process, the three alternatives selected to move forward to feasible alternatives evaluation are:

- **Alternative 1:** IPR via GWR (from SJ/SC) and expanded NPR
- **Alternative 2:** IPR via GWR (from Palo Alto /Sunnyvale) and expanded NPR
- **Alternative 4:** IPR via GWR (from Palo Alto/Sunnyvale and Morgan Hill) and expanded NPR

These alternatives will be refined and further evaluated in the feasible portfolios evaluation.

Section 6: Next Steps

The three alternatives selected to move forward to feasible portfolios evaluation will be developed to a preliminary (10 percent) design and further evaluated using detailed prioritization criteria and other factors, such as economics, environmental impacts/benefits, governance considerations, and risk.

Valley Water will continue to facilitate meetings and workshops with the PPG, Executive Leadership Group, Stakeholder Task Force, and the Board Recycled Water Committee to discuss and refine the Draft Master Plan Report. The Final Master Plan Report will be developed in close coordination with these partners and stakeholders.

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Attachment A: Market Assessment

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This attachment presents the market assessment used for the conceptual alternatives analysis. Note that while potential costs are referenced where available from source studies, costs are not a consideration for conceptual alternatives. Costs will be evaluated as part of the feasibility analysis.

A.1 PA/MV RWS

The PA/MV RWS delivers recycled water produced at the Palo Alto RWQCP to customers in Palo Alto and the North Bayshore area of Mountain View.

A.1.1 Palo Alto

The City of Palo Alto's 2008 Recycled Water Facility Plan (RWFP) identified 1,700 AFY in potential additional demand and organized potential customers into five geographic areas, shown on Figure A-1. The pink circles represent potential customers, with higher demands corresponding to larger circles. Arrows represent options for future expansion.

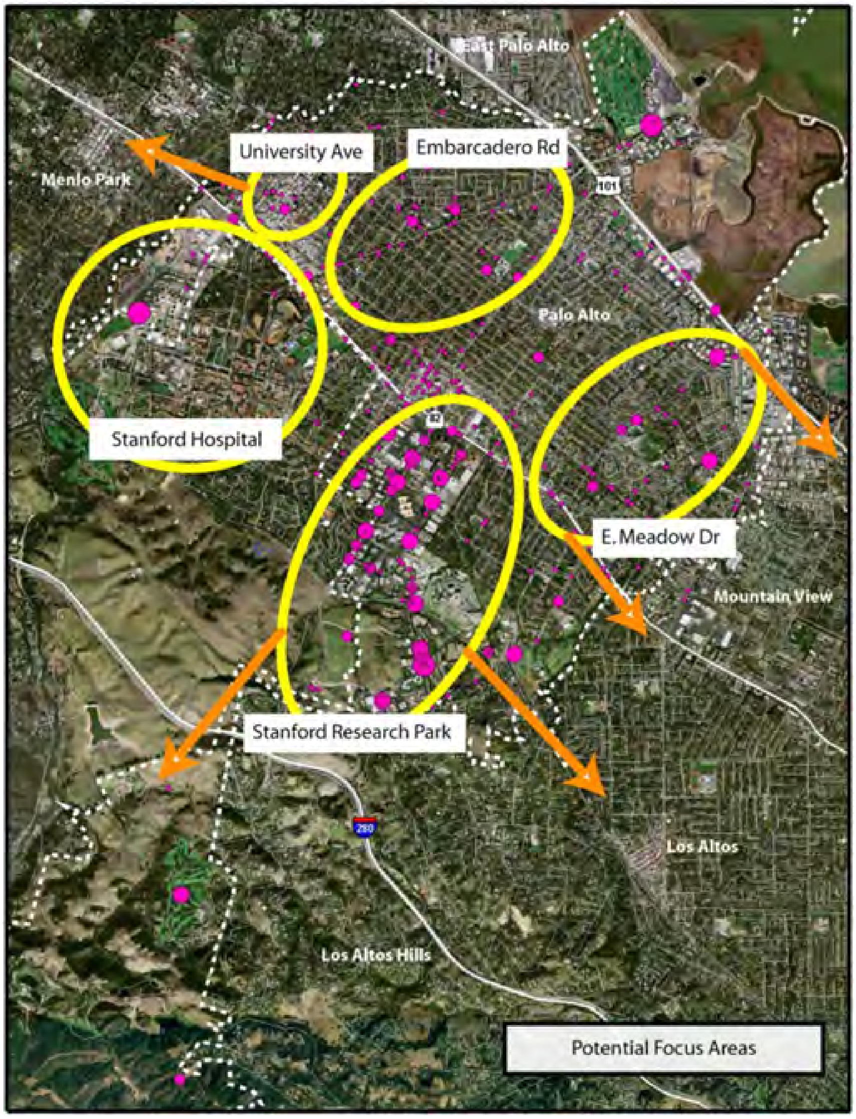

Figure A-1. Palo Alto: groupings of potential NPR customers

Source: 2008 RWFP

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The highest concentration of users is in the Stanford Research Park area, which is the focus of the plan. To serve these customers, the 2008 RWFP recommended connecting to the existing pipeline along East Bayshore Road (shown on Figure A-2) and proceeding southwest. This extension would add 900 AFY of demand, which matches the City's 2015 UWMP projection. The 2015 UWMP estimated long-term NPR demand at 1,750 AFY.

Figure A-2 illustrates the expected demand and recommended facilities to serve the East Meadow Drive and Stanford Research Park focus areas. According to the 2008 RWFP, the total capital cost (including pipelines, pumping, and user retrofits) for the recommended project is $33.5 million in 2008 dollars.

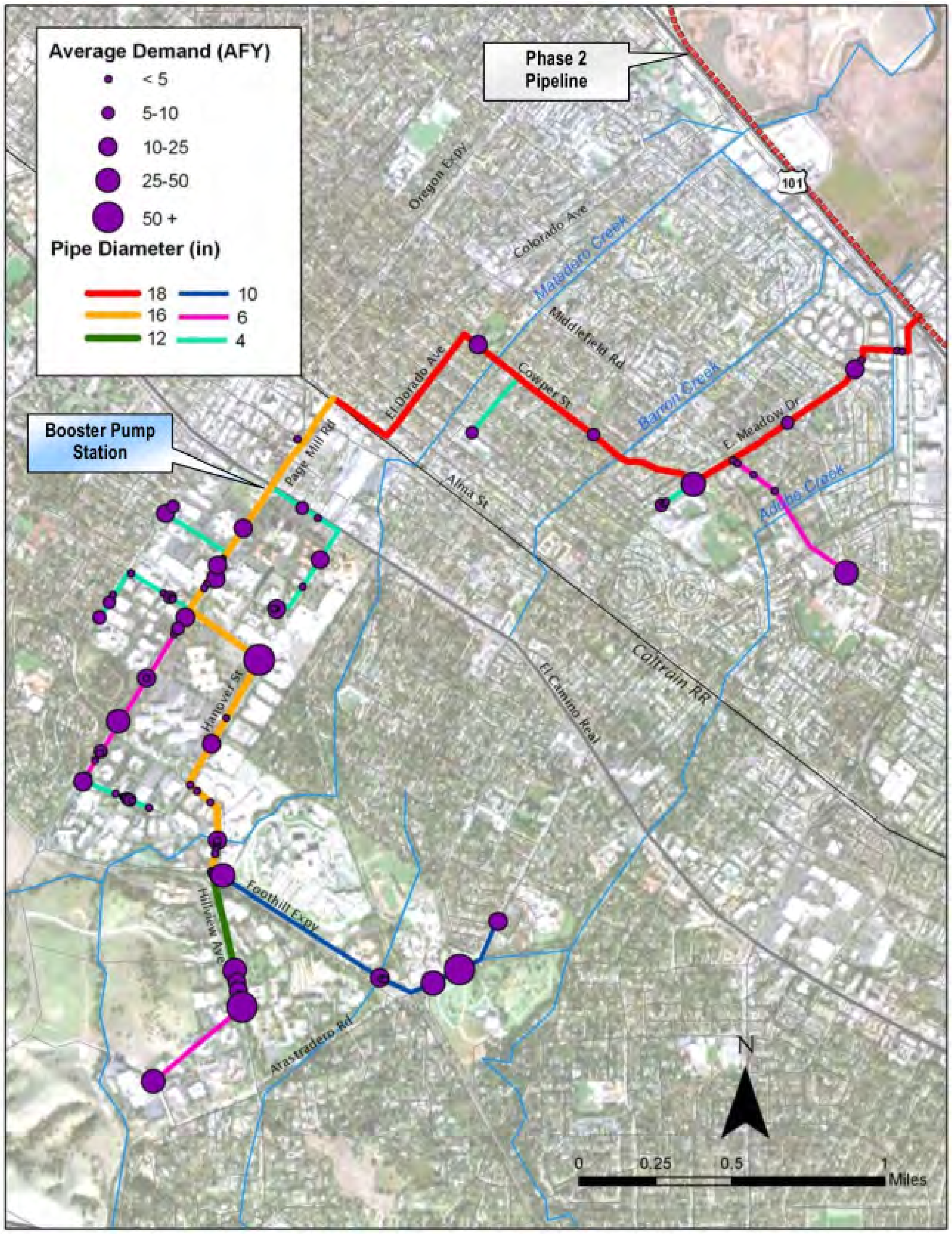

Figure A-2. Palo Alto: recommended NPR facilities

Source: 2008 RWFP

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A.1.2 Mountain View

The City of Mountain View's 2014 Recycled Water Feasibility Study (RWFS) identified five system expansion alternatives. Shown in Figure A-3, proposed options target larger potential users south of Highway 101, including the Domizile Homeowners Association, Rengstorff Park, Cuesta Park, and El Camino Hospital.

Additionally, the 2014 RWFS identified a potential intertie between the City of Mountain View and City of Sunnyvale recycled water distributions systems. This intertie would cross through Moffett Field and connect to the City of Sunnyvale near Enterprise Way. The alignment for this intertie is also shown on Figure A-3.

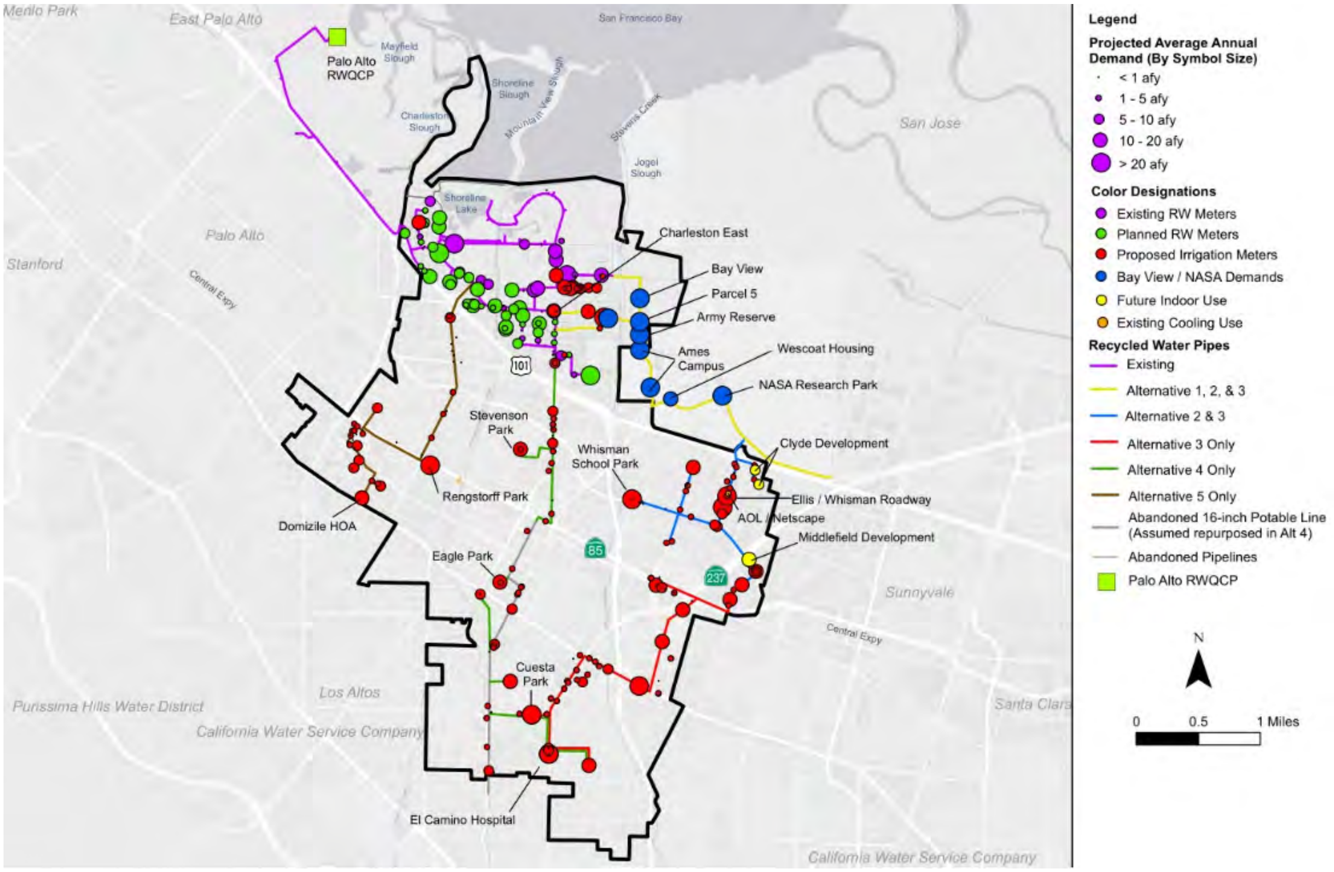

Figure A-3. Mountain View: NPR expansion alternatives

Source: 2014 RWFS

With the lowest unit costs ($2,650/AF [2014 dollars]) and relatively minimal environmental impacts, the National Aeronautics and Space Administration (NASA) Research Park and Whisman School Park alignments were selected for implementation. These correspond to the yellow and blue lines in Figure A-3. Because of financial challenges of implementing the expansion at once, the 2014 RWFS proposed dividing the project into three phases. In all, the recommended project would cost $23.7 million (2014 dollars) and add approximately 1,100 AFY of demand, for a total of 1,600 AFY. These demands include approximately 400 AFY delivered to users outside the City of Mountain View's water service area, which are associated primarily with Moffett Field.

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The City of Mountain View's 2015 UWMP projects a total long-term demand of 2,500 AFY, nearly 1,000 AFY more than the 2014 RWFS. Part of the discrepancy can be explained by projected deliveries outside the water service area, which are approximately four times larger in the 2015 UWMP. Meanwhile, projected deliveries inside the water service area are lower in the 2015 UWMP. The 2015 UWMP noted that estimates from the 2014 RWFS were updated based on "subsequent discussions with NASA, Google, and the City of Sunnyvale." Table A-1 compares the long-term demand projections by service area between the 2014 RWFS and 2015 UWMP.

Table A-1. Comparison of Projected Long-Term NPR Demands in Mountain View

Source	Inside Water Service Area (AFY)	Outside Water Service Area (AFY)	Total (AFY)
2014 RWFS	1,200	400	1,600
2015 UWMP	1,100	1,400	2,500

A.2 Sunnyvale RWS

The Donald M. Somers WPCP supplies the Sunnyvale RWS, which delivers water to customers in the cities of Sunnyvale and Cupertino.

A.2.1 Sunnyvale

In 2013, the City of Sunnyvale adopted a Feasibility Study for Recycled Water Expansion (FSRWE), which identified approximately 2,100 AFY of additional potential recycled water demand. The recommended expansion included creating a system loop via extensions to Washington Park, Las Palmas Park, and apartment complexes on South Fair Oaks Avenue, as well as an extension south on Wolfe Road to the Apple Campus 2. The total cost of the recommended expansion, including all optional extensions, was estimated at $114.1 million (2013 dollars). The Wolfe Road Main was completed in 2017, with funding help from Valley Water, Apple, and California Water Service Company (Cal Water). Figure A-4 shows the existing and proposed NPR system, color coded by construction phase.

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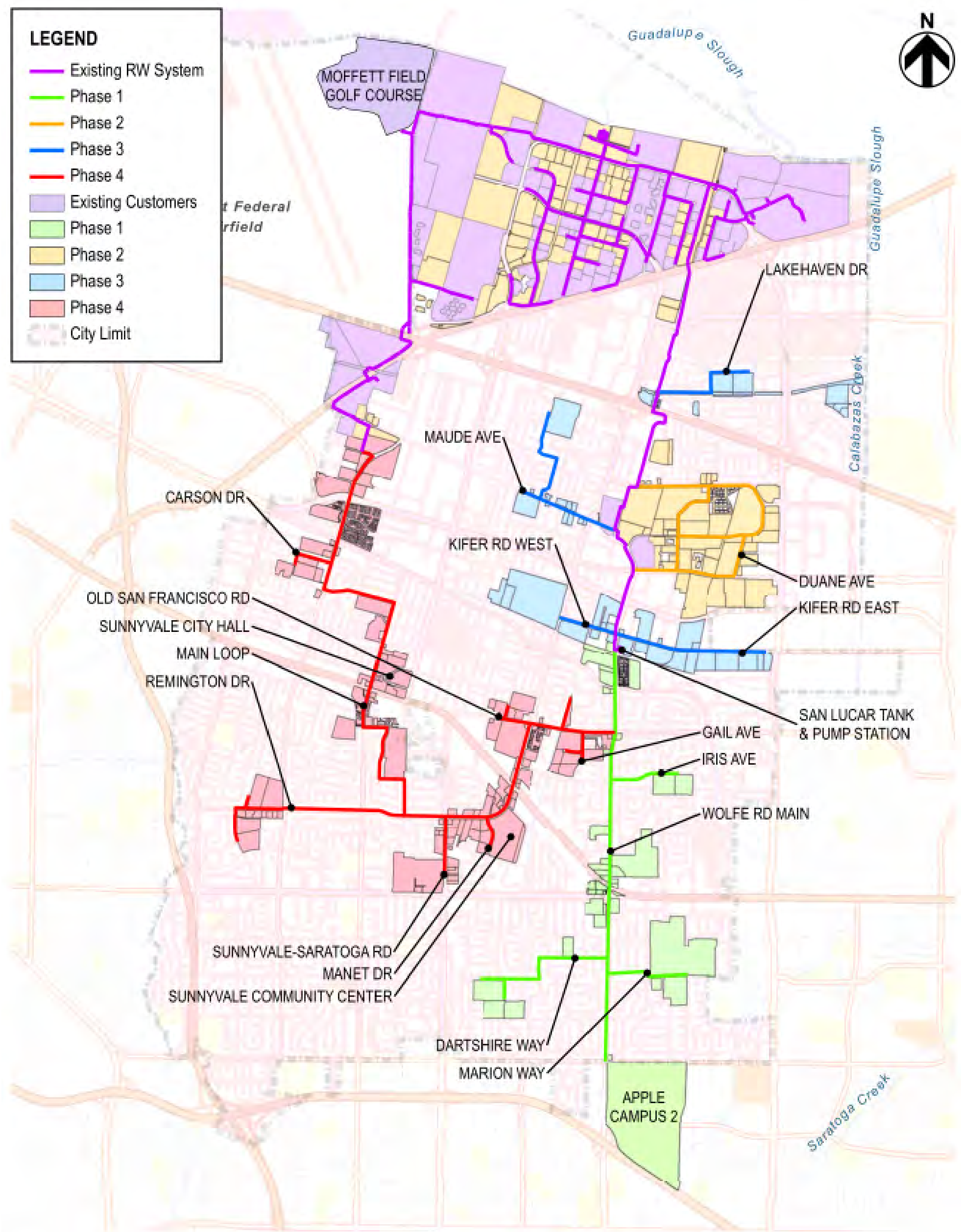

Figure A-4. Sunnyvale: NPR expansion and phasing

Source: 2013 FSRWE

The 2013 FSRWE estimates total long-term NPR demand reaching 3,100 AFY, compared to only 1,700 AFY in the 2015 UWMP. Following completion of the 2013 FSRWE, the City of Sunnyvale chose to not pursue additional recycled water projects until further direction from Valley Water was received regarding countywide recycled water planning. This reduced the NPR demand in the City of Sunnyvale's 2015 UWMP. The 2015 UWMP projects reaching 1,680 AFY by 2030, with no further demand growth beyond 2030. Most of the growth is due to increased landscape irrigation and dual plumbing, with less significant contributions from golf course irrigation and construction operations.

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A.2.2 Cupertino

Cal Water, along with San Jose Water (SJW) under a lease agreement with the City, retails potable water within the city of Cupertino. In 2012, SJW developed a *Recycled Water Feasibility Study* (RWFS) that investigated bringing recycled water to the city of Cupertino and western portion of the city of San José. Alignment T, as the extension was named, would utilize recycled water from the City of Sunnyvale's RWS, connecting near the Apple Campus 2. The 2012 RWFS proposed constructing Alignment T in three phases, costing $38.8 million (2012 dollars) and serving a total potential demand of 1,300 AFY. Figure A-5 shows proposed and optional Alignment T segments, along with target customers.

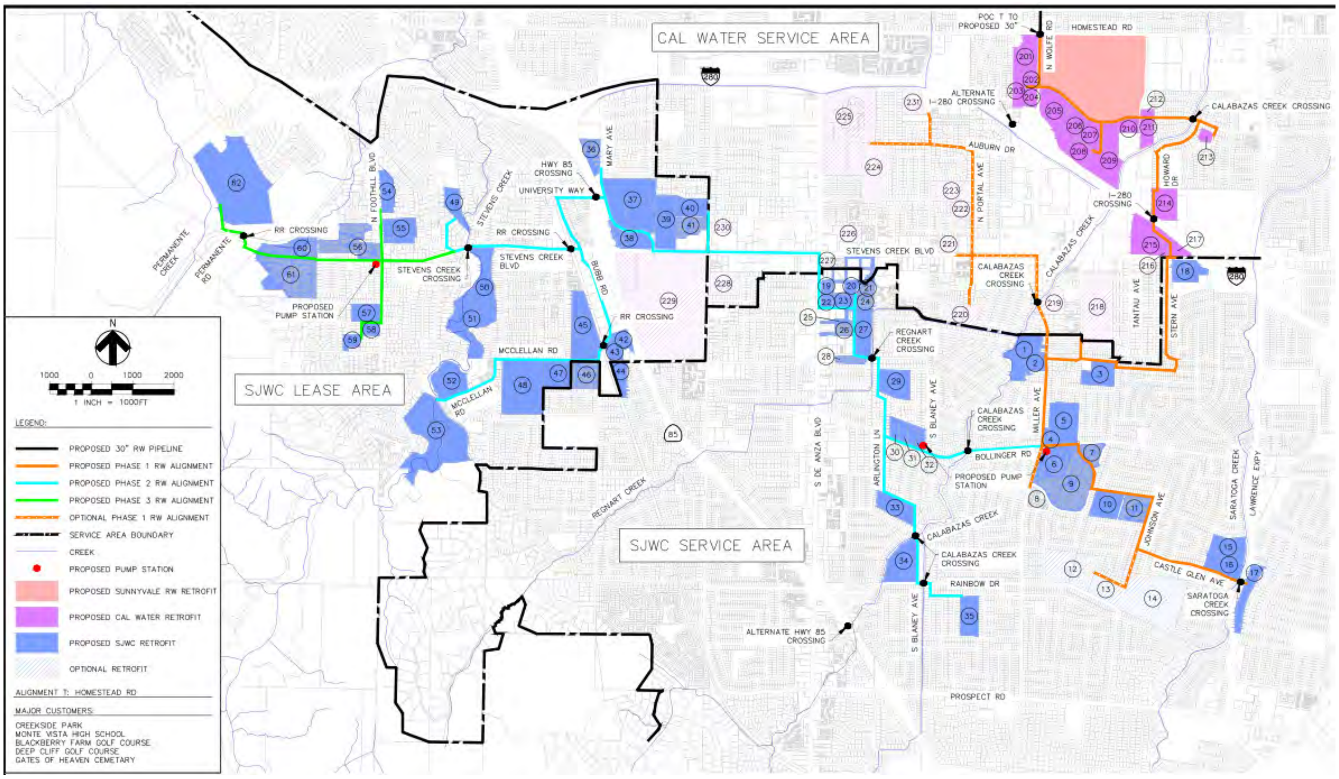

Figure A-5. Cupertino (Cal Water/SJW): proposed Alignment T facilities

Source: 2012 RWFS

Because SJW provides water service to Cupertino through a lease agreement that expires in 2022, it was not considered feasible to invest in Alignment T unless an agreement was in place to make this a financially viable option. Therefore, SJW did not include Cupertino NPR demands in its 2015 UWMP.

Cal Water's 2015 UWMP recycled water use projections include only Apple Campus 2 deliveries, which reach approximately 300 AFY by 2025. No additional demand growth is expected through 2035.

A.3 SBWR

SBWR delivers recycled water produced at SJ/SC RWF to customers in the cities of Santa Clara, San José, and Milpitas.

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A.3.1 Santa Clara

While the City of Santa Clara does not plan to expand its recycled water distribution system, NPR demand is expected to almost double by 2040 according to the City of Santa Clara's 2015 UWMP. The City of Santa Clara attributes the growth to a burgeoning data center industry, which uses large volumes of water for cooling. In addition, the City of Santa Clara expects significant development and several infill projects near existing pipelines, creating additional landscape irrigation and dual plumbing demand. Figure A-6 shows the actual and projected NPR demand from 1998 through 2040, when demand is expected to reach 6,900 AFY. In 2035, the target year for long-term demand comparisons, NPR demand is estimated at 6,500 AFY.

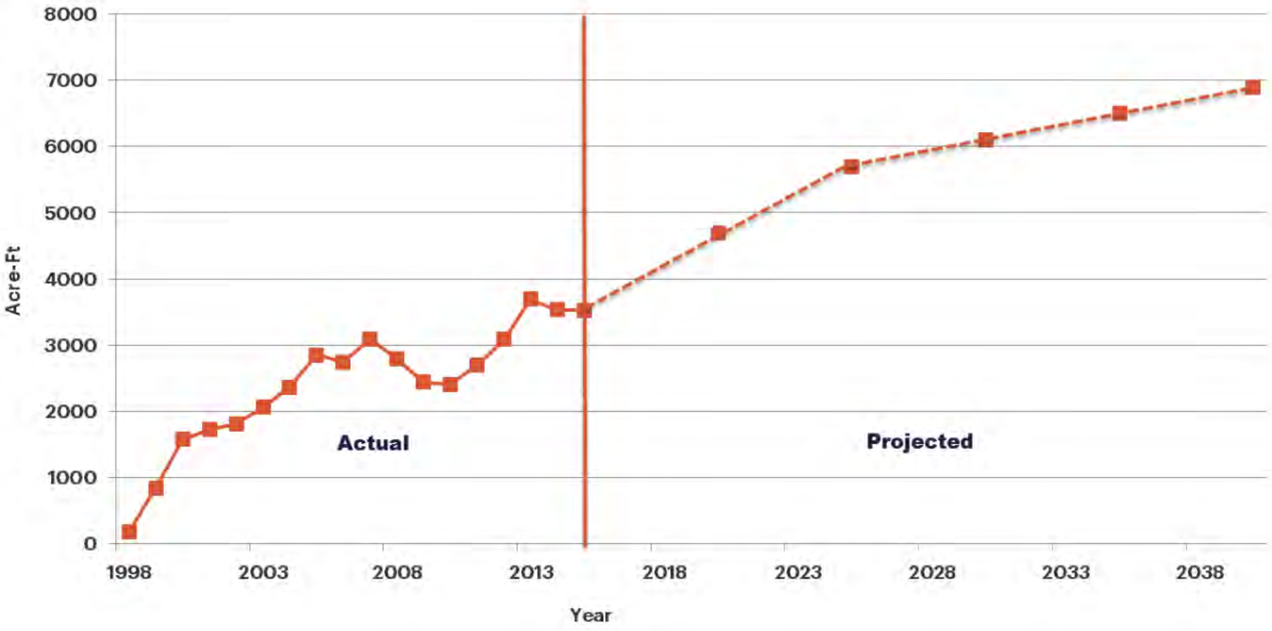

Figure A-6. Santa Clara: actual and projected recycled water demand

Source: Santa Clara 2015 UWMP

A.3.1.1 San José Municipal Water System

The San José Municipal Water System (SJMWS), one of the two NPR service providers in the city of San José, has not developed its own recycled water plan; however, SBWR conducted a market assessment of its service area in the 2014 SMP. The 2014 SMP projected approximately 2,700 AFY in additional demand, for a long-term total of approximately 7,300 AFY within the SJMWS service area. Increased demand is based on job and housing growth scenarios introduced in the *Envision San José 2040 General Plan Update* and is not associated with any specific recycled water expansion projects. Of note, the 2013 expansion of the Los Esteros Energy Center was expected to contribute between 1,000 and 2,000 AFY of additional demand (1,500 AFY was used in the SMP), a significant portion of the projected overall growth.

SJMWS's 2015 UWMP projects demand nearly doubling from 3,600 AFY in 2015 to 6,800 AFY in 2035. This total long-term demand is lower than SBWR's estimate, though 2040 estimates from the 2015 UWMP are right in line with SBWR. Both landscape irrigation (including golf courses) and industrial use are expected to increase, but industrial use will exceed irrigation demand in 2020 and grow more quickly in the following years.

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A.3.1.2 San Jose Water

SJW, the other NPR service provider in the city of San José, developed a *Recycled Water Master Plan* (RWMP) in 2009 that identified 17 potential alignments to expand the RWS throughout SJW's service area. A 2011 TM, the Recycled Water Master Plan – 2011 Update refined the 2009 market assessments and introduced two new alignments, for a total of 19. Through 2018, nine of the alignments proposed in the 2009 RWMP had been implemented, representing approximately 27 miles of new infrastructure. Constructing the remaining alignments would cost approximately $130.7 million (2011 dollars) and increase total irrigation demand by 5,600 AFY. Proposed alignments are shown on Figure A-7.

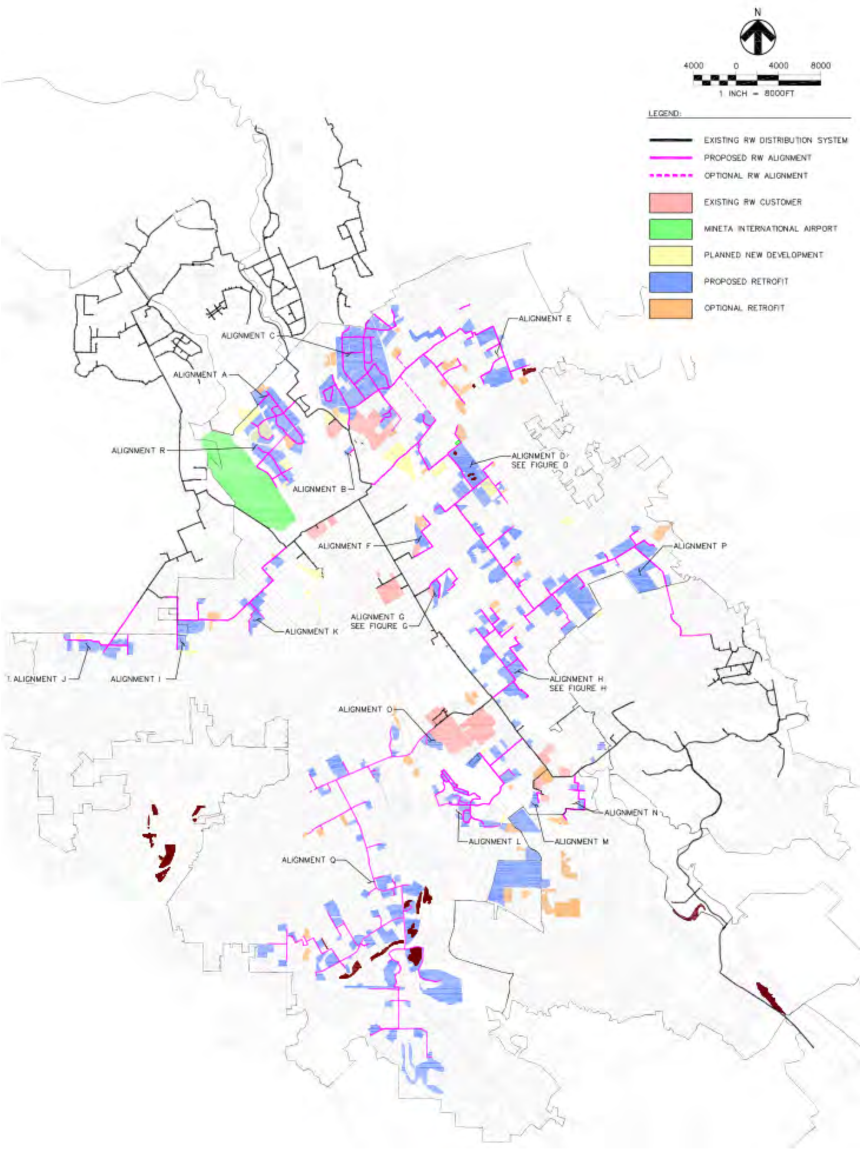

Figure A-7. San Jose Water: proposed recycled water alignments

Source: 2011 RWMP

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SJW's 2015 UWMP updated the demand estimates and proposed an implementation schedule for each alignment. Alignments A and R would be implemented first in 2016, with Alignment K completing the expansion plan in 2029. As mentioned in the Cupertino discussion, Alignment T was not included in the UWMP. Together, the extensions would increase demand by 6,400 AFY, for a total long-term demand of 8,400 AFY, achieved by 2035.

A.3.1.3 Milpitas

SBWR's 2014 SMP summarizes the City of Milpitas's long-term recycled water demands, which are expected to increase because of development around the Milpitas Transit Area and system extensions to Spring Valley Golf Course and Summitpointe Golf Club. These developments, along with an effort to convert cooling towers to use recycled water, combine for approximately 1,100 AFY in additional long-term demand. Total potential demand is 2,200 AFY. The 2014 SMP cites an aggregate cost for the entire SBWR system, so no Milpitas-specific costs are available for reference. Figure A-8 illustrates the proposed distribution facilities.

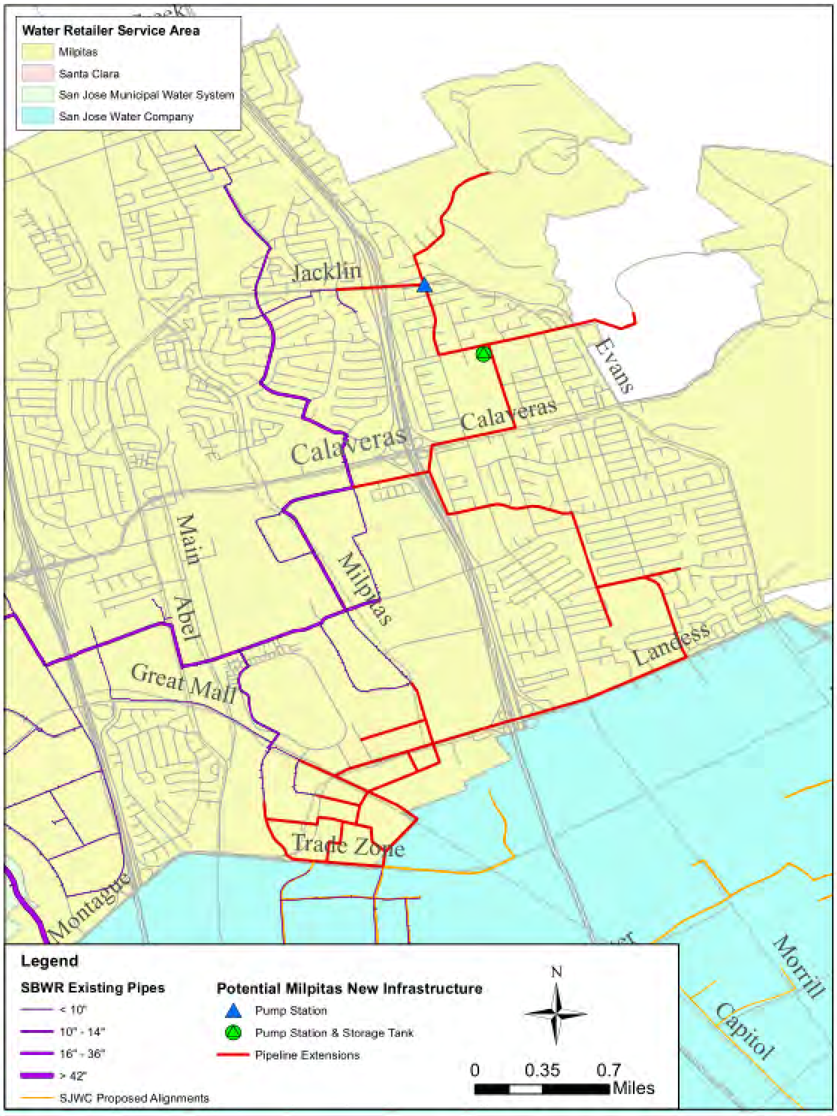

Figure A-8. Milpitas: proposed recycled water infrastructure

Source: SBWR 2014 SMP, Appendix 3A

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The City of Milpitas's 2015 UWMP projects more aggressive demand growth. While SBWR's SMP estimates an NPR demand of 2,200 AFY in its long-term projections (defined as 2035), the 2015 UWMP projects 2,500 AFY for the same timeframe and 2,700 AFY in 2040.

A.4 SCRWA

The SCRWA WWTP serves the cities of Gilroy and Morgan Hill. Currently, SCRWA produces NPR water for Valley Water, which distributes it to users located within about five miles of the WWTP, located south of the City of Gilroy.

A.4.1 Gilroy

In 2015, SCRWA and Valley Water completed a South County Recycled Water Master Plan Update (2015 MPU) that refined the NPR market, proposed NPR expansion alternatives, and developed a 20-year CIP. A market assessment identified potential future landscape irrigation, agricultural, and municipal/industrial users, who, along with limited-term customers (e.g., construction use), would add 4,200 AFY of demand. Including 2,000 AFY used currently, the total long-term, potential demand would be 6,200 AFY.

Figure A-9 shows the current system and various user types introduced in the 2015 MPU. "In-progress users" have been permitted to use recycled water but are not yet connected or not yet taking deliveries. "Baseline users" are close to the existing alignment and have expressed interest in recycled water. "Potential users" are candidates for recycled water that could be approached in the future, following system expansion.

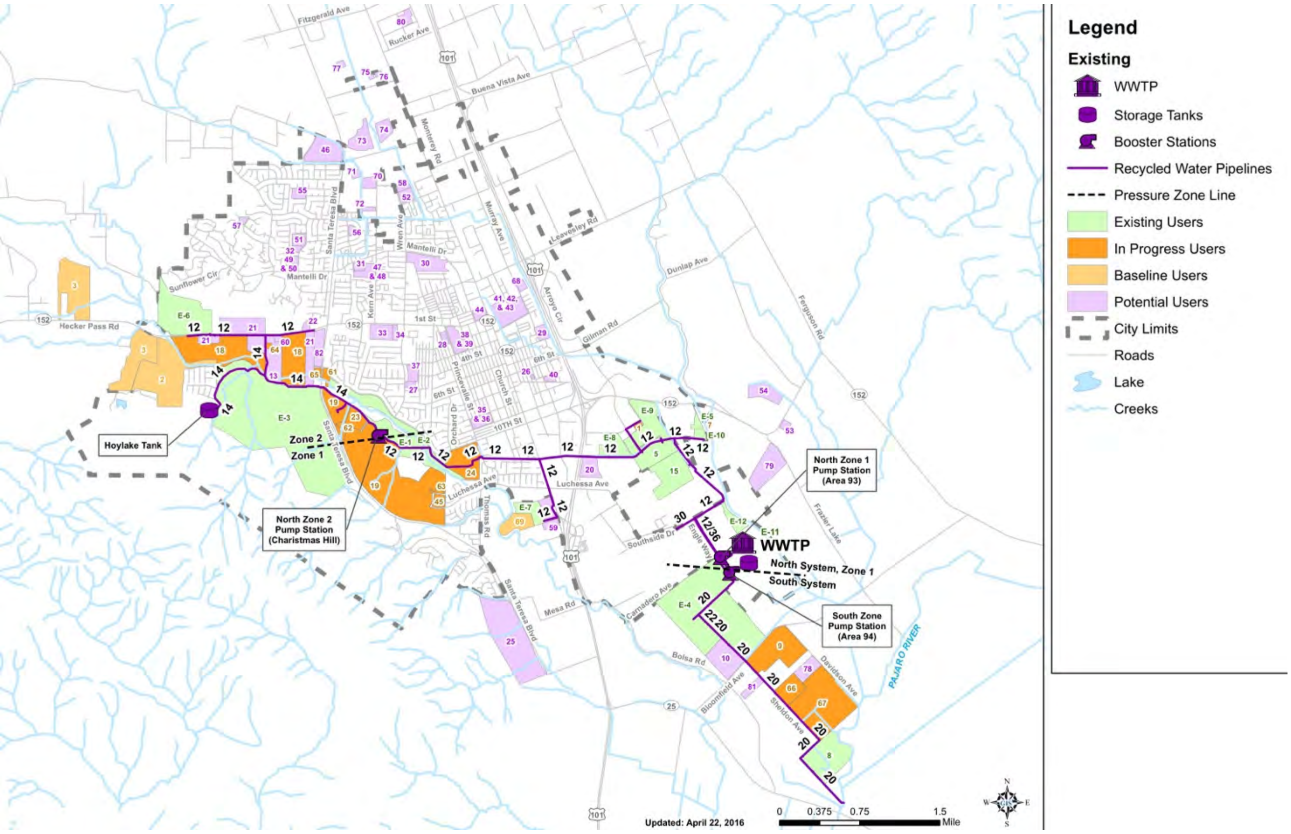

Figure A-9. Gilroy: existing RWS and potential users

Source: 2015 MPU

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The recommended CIP (shown on Figure A-10) includes new pipeline, pumping, storage, and treatment facilities. According to the 2015 MPU, it would cost approximately $98 million (2015 dollars) and add 1,200 AFY of demand, for a total of 3,700 AFY. Total long-term demand matches the City of Gilroy's 2015 UWMP.

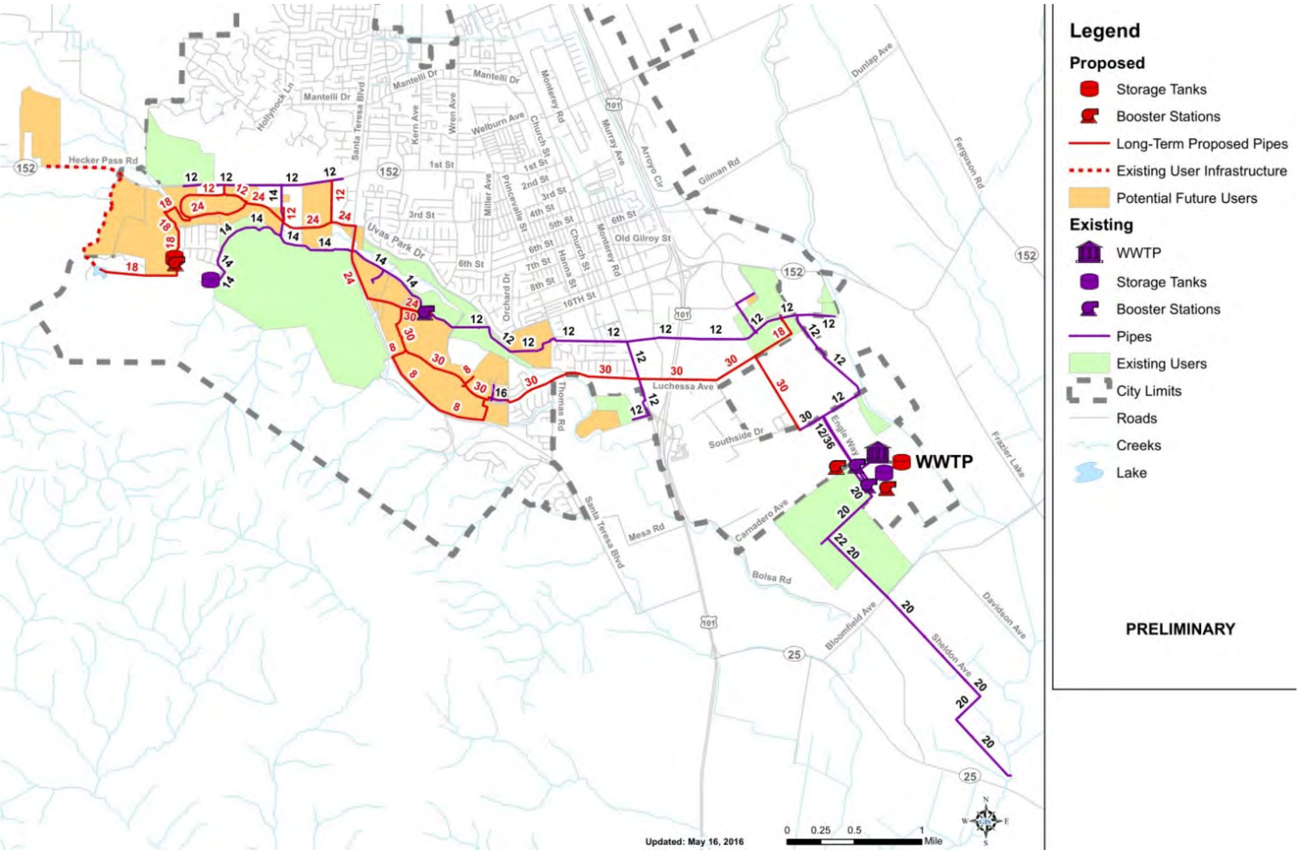

Figure A-10. Gilroy: recommended NPR system expansion

Source: Gilroy 2015 UWMP

A.4.2 Morgan Hill

Currently, the City of Morgan Hill does not receive recycled water from the SCRWA system. The 2016 RWFE examined three alternatives for extending recycled water service to Morgan Hill: two transmission main alignments (connecting Morgan Hill to Gilroy) and a satellite plant constructed in Morgan Hill. In conjunction, a Morgan Hill NPR market assessment was conducted, identifying 2,900 AFY of potential recycled water demand. Potential users are shown on Figure A-11.

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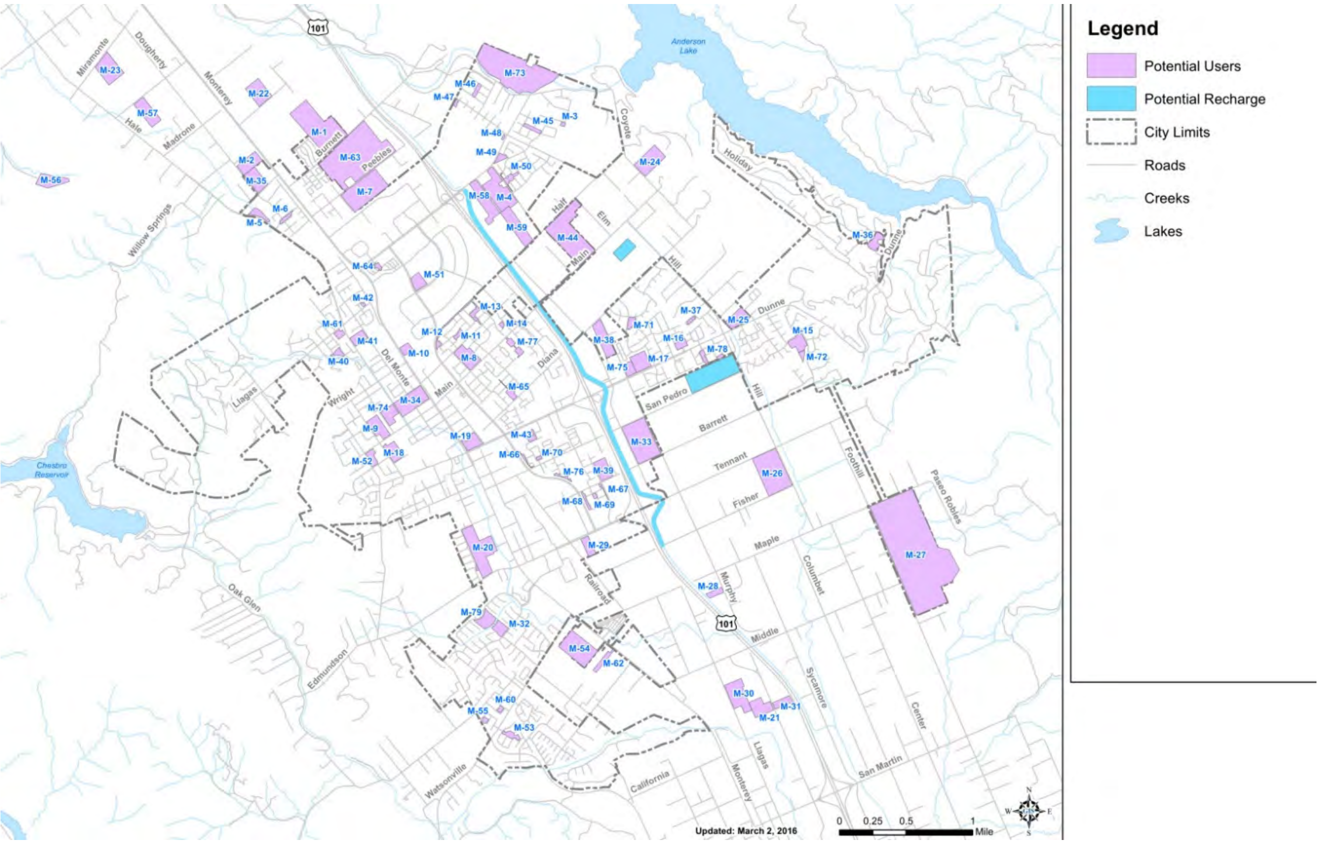

Figure A-11. Morgan Hill: potential recycled water users

Source: 2016 RWFE

Ultimately the 2016 RWFE concluded that NPR using source water from the SCRWA facility was not a feasible alternative in Morgan Hill. Additionally, a satellite plant that delivered recycled water for irrigation use would not be cost-effective. Existing customers in the city of Gilroy already use most of the available supply, and during wet months when supplies would increase, demand drops. Instead, the 2016 RWFE recommended using recycled water for GWR; a variation of this option is discussed further in Section 2.

A.5 Market Quantification Summary

Table A-2 summarizes the long-term NPR demands for each retailer, comparing projections from water retailers' 2015 UWMPs to previous retailer-specific recycled water plans (where available). The "previous study" projections include existing demand (when the plan was developed) plus any estimated demand from the plan's recommended project. Long-term UWMP demand is equal to the maximum demand projected through 2035.

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"Difference from Previous Study" compares the demand projections from the 2015 UWMPs to the previous recycled water plans. Large drops in potential demand, as with the City of Sunnyvale, could signify abandonment or major delaying of system expansion. Based on the 2015 UWMP and discussions with the City of Sunnyvale, NPR system expansion would be paused until Valley Water provides direction regarding countywide reuse efforts through the Master Plan. Smaller declines (City of Mountain View) suggest adjustments for new baseline conditions.

Demands are also subtotaled by Partner Agency and for the entire county. UWMP estimates are lower for the PA/MV RWS and Sunnyvale RWS, while 1,000 AFY of additional demand is expected for the SBWR system (fed by the SJ/SC RWF). Despite differences for individual cities, total countywide demand projections from the previous sources and 2015 UWMPs are within 2.5 percent of each other.

While previous studies and UWMPs anticipate between 32,000 and 33,000 AFY of countywide NPR demand, respectively, significant discrepancies at the retailer level mean that the most recent source should be used. Consistent with the baseline analysis, the conceptual alternatives analysis uses the 2015 UWMP projections, as they are more recent. The City of Morgan Hill's 2016 RWFE is the only alternate source that was developed after 2015, but both sources predict zero long-term recycled water use, so nothing changed in the period between publications. Using the most recent long-term demands is critical for developing relevant conceptual alternatives. Even in concept, an alternative must pass a basic flow accounting, and reliable NPR demands are an important piece of that exercise. NPR demand projections may be updated as new information becomes available from the Partner Agencies.

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Table A-2. Long-Term NPR Demands: Baseline Source vs. 2015 UWMP

Partner Agency	Retailer	Previous Study	Long-Term NPR Demand (AFY) From Previous Study[a]	Long-Term NPR Demand (AFY) From 2015 UWMP[b]	Difference from Previous Study	Explanation of Difference
PA/MV RWS	City of Palo Alto	2008 RWFP[c]	1,740	1,750	~0	N/A
PA/MV RWS	City of Mountain View[d]	2014 RWFS	1,200	1,100	-100	Lower actual demand in 2015
PA/MV RWS subtotal[e]			3,000	2,800	-200	
Sunnyvale RWS	City of Sunnyvale	2013 FSRWE	3,100	1,400	-1,700	Expansion on hold, pending Master Plan efforts
Sunnyvale RWS	SJW (Cupertino)	2012 RWFS	0	0	0	N/A
Sunnyvale RWS	Cal Water (Cupertino)	2012 RWFS	260	260	~0	N/A
Sunnyvale RWS subtotal			3,400	1,700	-1,700	
SBWR	City of Santa Clara	2014 SMP [f]	5,200	6,500	1,300	Additional development and data center growth
SBWR	San José Municipal Water System	2014 SMP [f]	7,400	6,800	-600	Timing: 2040 demand projections from UWMP are in line with SMP
SBWR	SJW	2011 RWMP [c]	8,400	8,400	~0	N/A
SBWR	City of Milpitas	2014 SMP [f]	2,200	2,500	300	Additional development in Transit Area
SBWR subtotal			23,100	24,100	1,000	
SCRWA	City of Gilroy	2015 MPU	3,700	3,700	~0	N/A
SCRWA	City of Morgan Hill	2016 RWFE	0	0	0	N/A
SCRWA subtotal			3,700	3,700	~0	
County total[e]			33,200	32,300	-900	

a. *Equal to existing demand at time baseline source was written, plus estimated demand assuming implementation of recommended project.*
b. *Projected demand in 2035.*
c. *Baseline source did not list existing use, so average of actual recycled water deliveries in 2005 and 2010 used (data from UWMPs).*
d. *Demands outside Mountain View's water service area are excluded.*
e. *Difference due to rounding.*
f. *In the absence of a retailer-specific plan, SBWR's SMP was used.*

Attachment B: NPR+ Multiplier Calculations

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The total effluent required to produce NPR+ ($Q_{effluent}$) is the sum of (1) secondary or tertiary treated effluent to be blended (Q_{NPR}), assumed to be one unit in this analysis, and (2) AWPF feed water ($Q_{AWPF\ feed}$) to produce enough purified water for blending. The amount of NPR+ produced ($Q_{enhanced}$) is lower than $Q_{effluent}$ because of water lost during the MF and RO processes (Q_{waste}).[5] An "NPR+ multiplier," equal to $Q_{effluent}/Q_{enhanced}$, can be calculated to determine the volume of effluent required to meet the equivalent NPR+ demand.

The purified water flow rate required for blending ($Q_{purified}$) depends on effluent flow rate and quality, purified water quality, and the target quality of NPR+. To remain consistent with the SBWR's 2014 SMP, this TM assumes that purified water has a TDS of 50 milligrams per liter (mg/L), and that the target NPR+ TDS is 500 mg/L. Equation 1 determines the purified water-to-effluent blending ratio based on these assumptions and the current effluent TDS for each Partner Agency.

$$\frac{Q_{purified}}{Q_{effluent}} = \frac{TDS_{target} - TDS_{effluent}}{TDS_{purified} - TDS_{target}} \qquad \text{(Equation 1)}$$

Where:

$Q_{purified}$ = flow rate of purified water (equal to $Q_{AWPF\ feed} - Q_{waste}$)

$Q_{effluent}$ = flow rate of effluent

TDS_{target} = NPR+ target TDS concentration, assumed to be 500 mg/L

$TDS_{effluent}$ = effluent TDS, in mg/L

$TDS_{purified}$ = purified water TDS, assumed to be 50 mg/L

Assuming one unit of Q_{NPR}, $Q_{purified}$ is equal to the blending ratio. With $Q_{purified}$ known, $Q_{enhanced}$ can be calculated as $Q_{NPR} + Q_{purified}$, and consequently, the NPR+ multiplier can be determined.

All four Partner Agencies have an NPR+ multiplier of approximately 1.1. That is, for every 1,000 AFY of NPR demand, approximately 1,100 AFY of effluent is needed to produce 1,000 AFY of NPR+. Flow balances presented in the following subsections account for improved NPR water quality at the Palo Alto RWQCP, Sunnyvale WPCP, and SJ/SC RWF. The alternatives do not contemplate changing the water quality of NPR produced at the SCRWA WWTP, so an adjustment is not necessary for that flow.

Calculations for the Sunnyvale WPCP are described here as an example, while results for the remaining Partner Agencies can be found in Table B-1. Based on the City of Sunnyvale's 2013 FSRWE, $TDS_{effluent}$ for the WPCP is assumed to be 930 mg/L. Equation 1 gives a blending ratio of 0.96, meaning that every unit of effluent must be blended with 0.96 unit of purified water to achieve a target TDS of 500 mg/L.

Using MF and RO recovery rates of 93 percent and 85 percent, respectively, it takes 1.21 units of effluent to produce 0.96 unit of purified water. Thus, after adding 1.00 unit of Sunnyvale WPCP effluent that goes directly to the NPR+ distribution system, 2.21 units of effluent produce 1.96 units of NPR+. Currently, 1.00 unit of effluent satisfies 1.00 unit of NPR demand, so assuming 1.96 units of NPR demand, the NPR+ multiplier for the Sunnyvale WPCP would be 1.13 (2.21/1.96). A process flow diagram of this example is shown on Figure B-1.

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[5] Typically, MF backwash returns to the front of the plant so is not actually lost. Including MF backwash in the waste stream provides a conservative (high) estimate of the amount of effluent needed to produce NPR+. Flow assumptions may be refined throughout development of the Master Plan.

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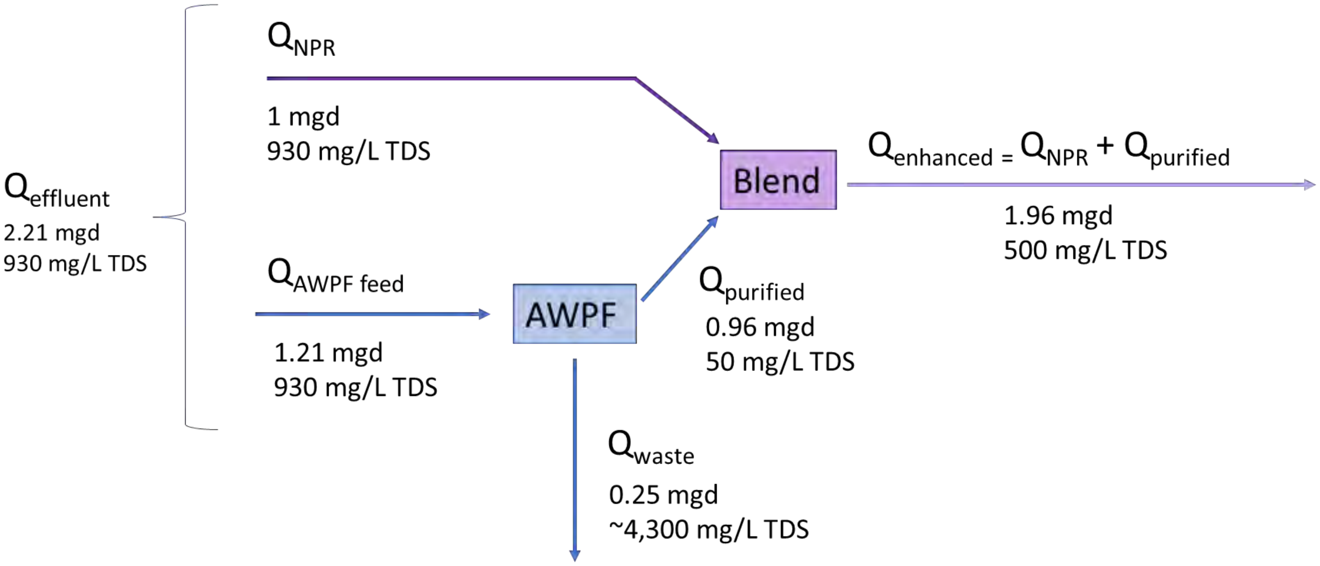

Figure B-1. NPR+ process flow diagram for Sunnyvale WPCP

Table B-1. NPR+ Blending Requirements

Producer	Effluent TDS (mg/L)	Purified Water Flow per Unit Effluent Flow	Purified Water Flow Percent	NPR+ Multiplier[a]
PA RWQCP	847[b]	0.771	43.5	1.12
Sunnyvale WPCP	930[c]	0.956	48.9	1.13
SJ/SC RWF	720[d]	0.489	32.8	1.09
SCRWA WWTP[e]	677[f]	0.392	28.2	1.08

a. *Assuming a purified water TDS of 50 mg/L, a target NPR+ TDS of 500 mg/L, and MF and RO efficiencies of 93% and 85%, respectively.*

b. *Average of TDS readings from 2015–17, as reported to California State Water Resources Control Board.*

c. *Average TDS from 2007–11 per City of Sunnyvale FSRWE (June 2013).*

d. *Per SBWR's 2014 SMP, Appendix 4A.*

e. *Not proposed to upgrade to NPR+. Flow analysis below assumes SCRWA will continue producing the same quality recycled water.*

f. *12-month average as of 12/31/2017, as reported to California State Water Resources Control Board.*

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Appendix G: ROC Management Reference Files

This Appendix will be included in the next version of the Draft Master Plan